SOUTH FLORIDA WATER MANAGEMENT DISTRICT

EAA Storage Reservoir A-1 Preliminary Design Report for Embankments and Canals

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ACCELER8
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1.0 INTRODUCTION

1.1 THE COMPREHENSIVE EVERGLADES RESTORATION PLAN (CERP)

The Comprehensive Everglades Restoration Plan (CERP) is charged with restoring the Everglades National Park, reviving habitat for more than sixty threatened and endangered species, restoring the natural water flows from Lake Okeechobee to Florida Bay, and establishing a reliable environmental, urban, and agricultural water supply while providing improved flood protection. The CERP mission is:

Restoration of America's Everglades is the world's largest environmental project of its kind

CERP was designed to capture, store and redistribute fresh water previously lost to tide and to regulate the quality, quantity, timing, and distribution of water flows. CERP will be implemented over 30 years at an estimated cost of $8 billion. CERP is being funded, managed, and implemented through a unique 50-50 partnership between the state and federal governments.

Situated at a central point at the head of the Everglades, the Everglades Agricultural Area (EAA) Reservoir A-1 has been described as a keystone to the success of CERP by allowing the necessary control of water with a flexible delivery schedule.

1.2 EAA RESERVOIR A-1 PROJECT

1.2.1 General

The EAA Reservoir A-1 Project is located in western Palm Beach County, generally in Township 46 and Range 37. It is situated in the EAA directly north of Stormwater Treatment Area 3/4 (STA-3/4), between the North New River Canal (NNRC) and Miami Canal, and west of U.S. Highway 27 (U.S. 27). It also adjoins the Holey Land Wildlife Management Area (WMA) to the southwest.

In accordance with CERP guidelines to capture, store and redistribute fresh water, the EAA Reservoir A-1 facilities will be designed to improve the timing of environmental water supply deliveries to STA-3/4 and the Water Conservation Areas (WCA), reduce Lake Okeechobee regulatory releases to the estuaries, meet supplemental agricultural demands, and increase flood protection within the EAA.

1.2.2 Project Purposes, Goals, Objectives, and Benefits

Implementation of the EAA Reservoir A-1 Project will meet objectives consistent with the ongoing work by the United States Army Corps of Engineers (USACE). The Project Implementation Report (PIR) being prepared by the USACE will provide the most current definition of the purpose and benefits of the EAA Storage Reservoirs Project. In accordance with the USACE's PIR, the objectives of the Compartment A Reservoir, comprising EAA Reservoirs A-1 and A-2, include:

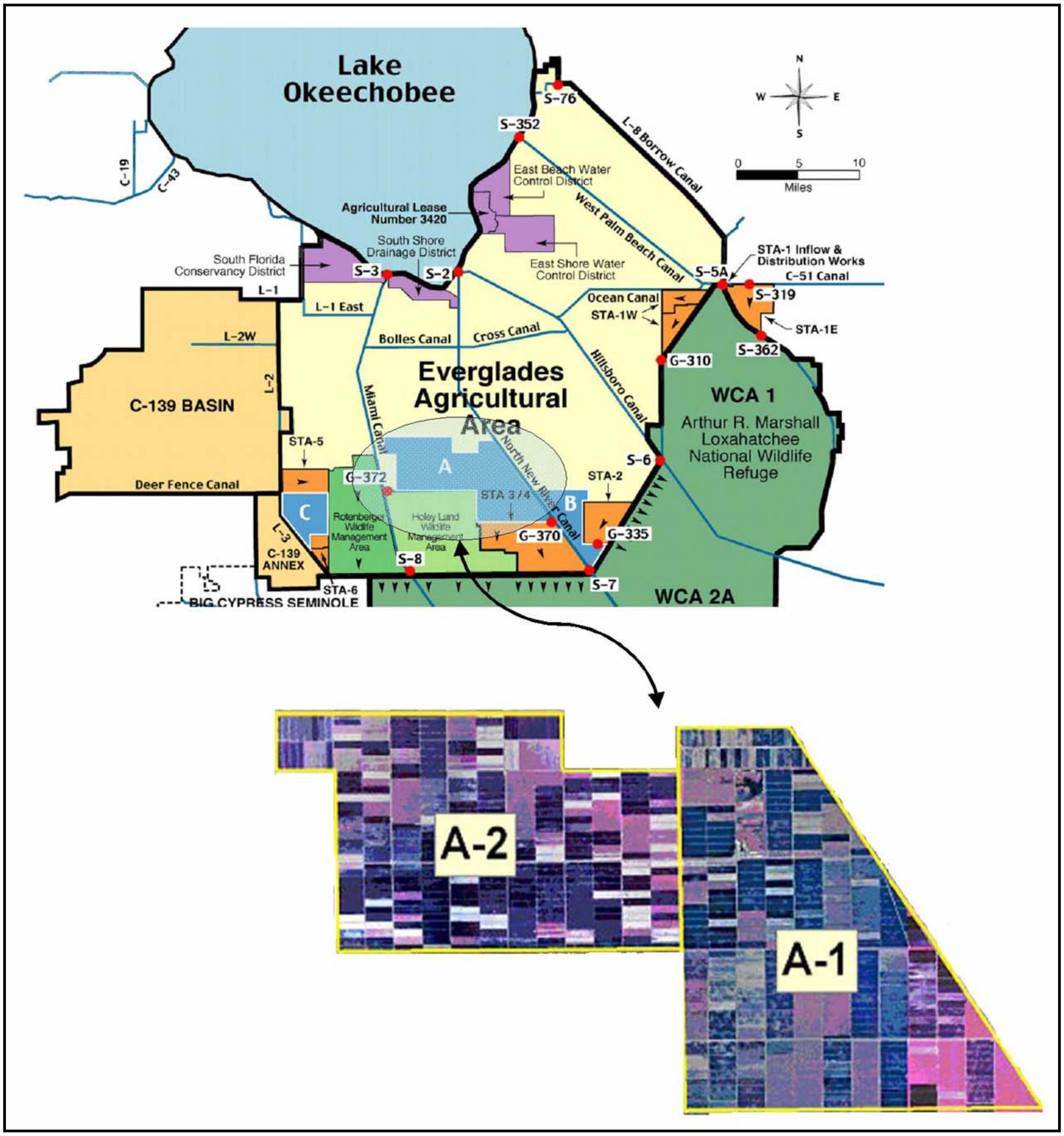
- Reduction of the Lake Okeechobee regulatory releases to the estuaries and backpumping from the Study Area (defined as that portion of the EAA that most influences its reservoir site) into Lake Okeechobee by sending the water to the EAA Reservoir A-1
- Improved environmental releases through the storage of water and release to the Everglades during the dry season
- Flow equalization and optimization of treatment performance of Stormwater Treatment Areas (STA) by capturing peak storm event discharges within reservoirs for slow release to the STAs
- Improved regional water supply for the agricultural community currently served by the EAA canals and other areas served by Lake Okeechobee

The EAA Reservoir A-1 Project covers approximately 17,000 acres and is designed to store stormwater originating within the S-2/7, S-3/8, S-236 and C-139 basins and releases from Lake Okeechobee, all located generally north of the EAA Reservoir A-1 Project site. A schematic of the EAA Reservoir A-1 and its relationship to the other EAA infrastructure is shown in Figure 1.2-1.

The EAA Reservoir A-1 is one of several reservoirs that are essential in fulfilling CERP's need to "capture, store and redistribute" fresh water. Further, it will improve the "quantity and timing" of delivery of fresh water to meet environmental and agricultural deliveries. Because of its critical place in the overall plan, the EAA Reservoir A-1's implementation was prioritized under the State of Florida's Acceler8 program. Projects in the Acceler8 program are implemented under an accelerated schedule with funding provided by the State of Florida. With the goal of providing maximum benefits for initial investment, the Acceler8 program will provide for construction of the EAA Reservoir A-1, with construction of EAA Reservoir A-2 to follow at a future date.

Project objectives and analysis of alternatives are covered in detail in the Basis of Design Report (BODR).

Figure 1.2-1 EAA Reservoir A-1 and Surrounding Infrastructure



1.2.3 Key Features

The key features of the EAA Reservoir A-1 Project include the following:

- Approximately 190,000 acre-feet of storage with a perimeter embankment and seepage canal
- Northeast pump station that pumps from NNRC estimated at 3,600 cubic feet per second (cfs) capacity, expandable to 5,000 cfs
- Connector canal from the NNRC to the new northeast pump station
- Seepage pump stations

- Gated discharge structures
- New four lane bridge on U.S. 27 across the new connector canal

The EAA Reservoir A-1 is intended to store water from the S-2, S-6, and S-7 Basins, collected from the NNRC, and release it to STA-3/4 for treatment before release to WCA-3A.

1.2.4 Plans for Further Development

The EAA Reservoir A-1 Project is the first phase of an ultimate EAA Reservoir Storage System that could store approximately 360,000 acre-feet of water over 30,000 acres of South Florida Water Management District (SFWMD) owned land between the NNRC and the Miami Canal. The USACE PIR process is currently evaluating Compartment A, which includes EAA Reservoir A-1 and EAA Reservoir A-2. Currently, only EAA Reservoir A-1 is part of the Acceler8 program. It is anticipated that the design and construction of EAA Reservoir A-2 will follow in a few years.

1.2.5 Scope of Work for Work Order 13

The scope of work for Work Order 13 is for preliminary engineering design services (30 percent design) for the EAA Reservoir A-1 embankment and associated canals. Preliminary design services for the associated pump station, other related control structures, and U.S. 27 bridges are not included in this Work Order. However, preliminary site layout for all structures will be included.

The task will include preliminary design and layout of the embankment alignment and cross sections, canals, access roads, and public access areas.

The design will be based on the conclusions from the Basis of Design Report (BODR), SFWMD Standards, and technical memoranda developed during previous work orders. A discussion of the Basis of Design is included in Section 5 of this report, and Lists of Drawings and Technical Specifications are included in Sections 8 and 9, respectively.

2.0 SITE CONDITIONS

The planned EAA Reservoir A-1 Project is located about 16 miles south of Lake Okeechobee in western Palm Beach County, Florida. It is in the Everglades physiographic area, an area of low relief with the natural ground surface of the EAA Reservoir A-1 Project site lying generally between elevations 8 and 11 feet NAVD88.

The EAA Reservoir A-1 site is an agricultural area primarily used for growing sugarcane. The area is drained by a system of canals constructed largely during the second half of the last century under the United States Army Corps of Engineers' (USACE) Central and Southern Florida Project. Flooding and draining these canals is used by the local sugar producers to regulate the groundwater level during planting and harvesting of the primary crop (sugarcane).

2.1 *CLIMATE*

The climate of southeast Florida is characterized as subtropical. The average annual temperature in Palm Beach County, Florida is approximately 73 degrees Fahrenheit. According to the Southeast Regional Climate Center (one of six regional climate centers in the United States directed by the National Oceanic and Atmospheric Administration [NOAA]), the average maximum daily temperature for the Belle Glade Experimental Station (No. 080611) was 83.5 degrees Fahrenheit for the period of record May 1, 1924 through February 29, 2004. The average minimum temperature for the same period of record was 61.7 degrees Fahrenheit. Average total precipitation at the Belle Glade Experimental Station for this period of record was 55.32 inches. The Belle Glade Experimental Station is approximately 10 miles north of the EAA Reservoir A-1 Project site.

Approximately 75 percent of the annual precipitation occurs during the wet season months of June through October. During this season, scattered and isolated convective thunderstorms occur frequently over land. Tropical storms and hurricanes also occur during the wet season and can provide significant rainfall and extreme winds in a short period of time. Rainfall from November through May (the dry season) is usually the result of large frontal systems from the north and are broadly distributed rather than localized. According to the Southeast Regional Climate Center, the wettest average month for the period of record is June (8.52 inches), while the driest average month for the period of record is December (1.71 inches).

2.2 *LAND USE DURING CONSTRUCTION*

The EAA was designated by the United States Congress in 1948. It is bounded by Lake Okeechobee on the north and the Everglades National Park on the south. The EAA was created as a result of draining the northern Everglades for agricultural use. It encompasses about 27 percent of the historic Everglades and consists of an area of approximately 700,000 acres of farmland. The major crop in the EAA is sugarcane, but winter vegetables are also grown.

Nearly the entire EAA Reservoir A-1 Project site, as well as adjoining lands to the north, northwest, and east, is designated for sugarcane production. A small rectangular-shaped parcel in the northern portion of the EAA Reservoir A-1 Project site is designated industrial land use, and was occupied by the Talisman Sugar Corporation processing facility. The Holey Land tract is southwest of the EAA Reservoir A-1 Project site and is designated as freshwater marshes with sawgrass. The southern adjoining property is occupied by STA-3/4.

Much of the acreage currently designated for sugarcane production is to remain in production during construction of the EAA Reservoir A-1 and associated facilities. In conjunction with this use, the existing interior canals, access roads, pumping stations, and electrical power lines serving the area need to remain in service. A land use plan showing the areas and facilities to remain in service during the construction period is shown on Sheet G06 of the Drawings.

2.3 *GEOLOGY AND SOILS*

The EAA Reservoir A-1 Project site has been investigated in a progressive sequence of borings spaced throughout the site area. One hundred forty-five borings were completed for the South Florida Water Management District around the reservoir perimeter in 2003 and early 2004. Twenty borings to a depth of 50 feet below ground surface (bgs) were completed at the EAA Reservoir A-1 Project Test Cell site for the Test Cell Project design in December 2004, and an additional eight borings to 100 feet depth were completed during the Test Cell construction in early 2005. During the summer of 2005, 158 conventional rotary borings and 5 rotosonic borings were completed bringing the boring spacing to roughly 1000 feet around the site perimeter and 2000 to 4000 feet across most of the site interior. Twenty-eight of the rotary borings extended to a depth of 100 feet, while the remainder were drilled to depths ranging between 8 and 42.5 feet. The depths of the rotosonic borings ranged between 220 and 250 feet.

The boring plan and profiles are included in Section 12 – Calculations of this report.

The borings generally penetrated through about 1/2 to 2 feet of surficial peat/muck and marl, then through 18 to 35 feet of primarily carbonate sand and limestone, and then into primarily shelly quartz sand with sparse limestone to a depth between 61 and 89 feet. The marl beneath the peat and muck is known by some authors as the Lake Flirt Marl, but is undifferentiated from the peat and muck layer for this report. The upper carbonate sand and limestone constitutes the Fort Thompson Formation at the site. Below this, the shelly sand and sparse limestone constitutes the Caloosahatchee Formation and the underlying Pinecrest Sand Member of the Tamiami Formation.

Below 61 to 89 feet depth, the 100-foot rotary borings and the rotosonic borings penetrated into primarily shelly, carbonate sand again but mixed with varying proportions of fine, quartz sand and sandy limestone gravel, the Ochopee Limestone Member of the Tamiami Formation. The rotosonic borings penetrated through the Ochopee Limestone and a shelly, silty, fine quartz sand, and then into a distinct olive gray unit to their completed depths. The top of the shelly, silty sand, referred to as the Unnamed Sand was at between 140 and 177 feet depth. Between 191 and 200 feet depth they penetrated into olive gray Peace River Formation, the upper formation of the Hawthorne Group, that grades downward from very fine quartz sand to sandy clay.

The top of the Fort Thompson Formation consists of a limestone layer generally about 4.5 to 5 feet thick, which is locally called caprock. The caprock is generally white, light gray, tan or yellowish brown with variable amounts of weathering; it is jointed and contains solution cavities and weakly cemented, porous zones. The caprock is underlain by a silty carbonate sand with localized hard limestone layers extending down to the Caloosahatchee Formation. Another hard limestone layer 1.5 to 3 feet thick is often encountered along the contact between the Fort Thompson and the Caloosahatchee. A thinner, hard limestone layer about 1/2 to 1 foot thick is sometimes encountered at around 16 to 17 feet deep. The sand and lower limestone layers are generally white to very pale brown. Laboratory testing of the sand sampled in the borings averaged 83.6 percent calcium carbonate content with an average of 19.9 percent passing the #200 sieve in gradation tests. The Unified Soil Classification (ASTM D422) for the SPT samples tested (90 tests) were mostly SM (53) with some SW-SM (12), SP-SM (6), and GP-GM (4) and with occasional GM (3), SP (3), GW (1), GW-GM (2), CL-ML (2), ML (2), and SW (1). Visual inspection of the sand samples from the borings reveals that they include shell fragments, and tend to be angular and platy.

The top of the Caloosahatchee Formation is composed of fine grained, subrounded, shelly quartz sand. The Caloosahatchee Formation and the underlying Pinecrest Sand Member of the Tamiami Formation cannot be differentiated in the borings. At the site, the two average a total of about 41 feet thick. Samples sent for laboratory testing were assigned Unified Soil Classifications of mostly SP-SM (43), SM (23), and SW-SM (15) and occasionally SP (8), GP-GM (5), GP 1)), and GM (1). The proportions of carbonate to quartz sand vary. The sampled sand indicated an average calcium carbonate content of 36.1 percent, and an average 10.7 percent of material passing the #200 sieve. The primary color of the geologic material in the Caloosahatchee Formation and the Pincrest Sand is light greenish gray.

Samples tested from the Ochopee Limestone Member of the Tamiami Formation averaged 65.8 percent carbonate and 11.7 percent passing the #200 sieve. The samples were assigned Unified Soil Classifications of mostly SP-SM (38), SM (24), and SW-SM (17) with a few GP-GM (4) and GW-GM (2). The Ochopee Limestone is generally light gray in color.

The Unnamed Sand is generally light yellow-gray. Samples tested averaged 47.6 percent carbonate and 24.4 percent passing the #200 sieve. The samples were assigned Unified Soil Classifications of SM (8), SP-SM (4), and CL-ML (1)

The Peace River Formation is olive gray in color. Samples tested averaged 27.2 percent carbonate and 52.2 percent passing the #200 sieve. The samples were classified as SM (7), ML (3), CL (2), and CH (1)

2.4 *SEISMICITY*

The Uniform Building Code Seismic Zone Map (USACE 1995), shows that the entire state of Florida is in seismic Zone 0. There are no known active or capable faults in Florida, and no capable faults or recent earthquake epicenters are known to exist near the Project site. The United States Geological Survey (USGS) Earthquake Hazards Program website lists 28 earthquake epicenters within 300 kilometers of the EAA Reservoir A-1 test cell site. Of these, 20 are associated with a January 1942 event in the Everglades area attributable to blasting.

The National Oceanic and Atmospheric Administration (NOAA) database shows there have been 136 recorded instances of felt ground motion in Florida since 1879, the first year in the record. Of these, many are the result of earthquakes centered outside of Florida, most notably the September 1886 earthquake at Charleston, South Carolina but also earthquakes centered in Cuba. Of the rest, many are of doubtful seismic origin, some are attributable to blasting such as the 1942 event noted above.

Of the historical ground motion events reliably attributable to seismic events in Florida, only one produced damage. This was a Modified Mercalli VI series of two shocks on January 13, 1879. Each lasted about 30 seconds and was felt from Savannah, Georgia on the north to Daytona Beach, Florida on the south. Damage was minor, including cracked and fallen plaster and articles thrown from shelves.

An inquiry at the USGS website for the latitude and longitude (N26.46301 and W80.68098) of the EAA Reservoir A-1 Test Cell site returned a probabilistic peak ground acceleration of 3.28 percent for a 2 percent possibility of exceedance in 50 years. De-aggregation plots of the probabilistic seismic hazard for the test cell site showed that the largest contributor to the hazard for long period (1 and 2 second period) seismic ground motion was from a M_W 7.3 earthquake (1886, Charleston, South Carolina). For short period (PGA and 0.2 second period) seismic ground motion the largest contributor is an earthquake of about M_W 5 within 50 kilometers of the site.

Based on available data, the seismic hazard and the risk of damage due to seismic events in Florida and at the EAA Reservoir A-1 site are considered to be low.

2.5 *SURFACE WATER HYDROLOGY*

Lake Okeechobee provides water south to the EAA through the NNRC and the Miami Canal. The Miami Canal flows south to the G-372 pump station, and then continues south into the Everglades Protection Area. The G-372 pump station pumps water into the STA-3/4 Supply Canal which currently feeds the Holey Land WMA and STA-3/4. The NNRC flows south to G-370 pump station and continues on south into the Everglades Protection Area. The NNRC will be used to supply the new northeast pump station located at the northeast end of the EAA Reservoir A-1. The G-370 pump station currently feeds the east end of the STA-3/4 Supply Canal.

There are numerous secondary agriculture canals that connect to the major canals along with seepage ditches common outside the levees. The secondary agriculture canals are responsible for north-south water movement.

The EAA Reservoir A-1 embankment will be designed to withstand the wind and precipitation design conditions identified in draft DCM-2 (Haapala Et Al., 2005a). The conditions were 1) 100 year wind with probable maximum precipitation, 2) category five hurricane with 100-year storm, 3) probable maximum wind (200 mph), and 4) a storm specific wind and precipitation (Hurricane Easy). These conditions are described in Section 5.3 of the BODR.

Design conditions affecting the EAA Reservoir A-1 include:

- 100-year wind speed 103 mph
- Probable Maximum Precipitation 54 inches
- Design wave height 6.65 feet
- Wind setup 2.1 feet
- Wave run-up 6.0 feet
- Maximum water level 24.6 feet

2.6 *GROUNDWATER HYDROLOGY*

Since the intermediate groundwater confining unit is located approximately 200 to 250 feet below ground surface and will restrict any seepage from EAA Reservoir A-1 that might reach this depth, only the surficial aquifer system lying above the confining unit is of concern for this project. With the high degree of communication between groundwater and surface water in the area, the groundwater gradient in the surficial aquifer system is controlled to a large extent by the operation of the hundreds of canals throughout the region. Therefore, even though the general regional gradient in the surficial aquifer system is believed to be southward, localized gradients may actually be in other directions in portions of the area surrounding the EAA Reservoir A-1 site due to the operation of canals and wells in the region. Future seepage from the EAA Reservoir A-1, the operation of the seepage canal, and modifications to the operation of the NNRC will also change these groundwater gradients in the surficial aquifer system near the EAA Reservoir A-1.

To interpret the groundwater pressure profile in the surficial aquifer system when seepage occurs, a series of more than 70 piezometers were installed for the Test Cell Project. The pressure readings from the piezometers were used to determine both the horizontal and vertical hydraulic conductivity (K_h and K_v, respectively) for each of the geologic units comprising the surficial aquifer system using both three-dimensional and two-dimensional groundwater models. The K_h and K_v values (derived by calibrating each of the groundwater models to the measurements taken during the Test Cell Project) are shown in Table 2.6-1.

Table 2.6-1 Hydraulic Conductivity Values Determined by Test Cell MODFLOW Model

Layer	K_h (feet/day)	K_v (feet/day)
Muck/peat and marl[1]	100	100
Caprock	500	1.1
Fort Thompson Formation	400	10
Caloosahatchee Formation	400	8
Tamiami Formation [2]	36	18

[1] Muck was removed from Test Cells, so calibration of the K values for the muck was not possible. The listed values were determined by the United States Army Corps of Engineers (USACE) through laboratory/field testing of the muck which were K_h = 40 feet/day and K_v = 9 feet/day (USACE, 2005). These values were increased as shown to account for the significant area where muck does not exist (Seepage Evaluation, Groundwater Model Memorandum, Black & Veatch, July 11, 2005).

[2] The Test Cell piezometers did not penetrate the deeper portions of the surficial aquifer system, so calibration to the published K values for the Tamiami Formation was not possible. The above conductivities reflect the USACE's values determined from laboratory/field testing.

2.7 *ENVIRONMENTAL CONDITIONS*

Under CERP, an area of land called Parcel A in the center of the EAA south boundary was designated as the site for a storage reservoir. Parcel A consists of about 30,000 acres including approximately 583 acres of open water, 97 acres of shrub and brushland, 206 acres of wetlands, and the remaining acres in agricultural use. Under the Acceler8 program, Parcel A was divided into two portions: A-1 and A-2. EAA Reservoir A-1 is approximately the Eastern half of Parcel A over an area of close to 17,000 acres. Historically, the project area was predominantly sawgrass marsh but in the mid-1900s it was drained for agricultural production.

The discussion of environmental conditions focuses on two specific issues: (1) vegetation and wetlands and (2) endangered species. A summary of the information follows and more detailed information is contained in the BODR (Appendix 2-1). Environmental Site Assessments are described in Section 2.7.3.

2.7.1 Vegetation and Wetlands

2.7.1.1 Existing Conditions

The EAA Reservoir A-1 Project area contains five verified wetlands, totaling 205.88 acres. The habitat quality of the five verified wetlands was determined as one Category 1 wetland (13.07 acres), one Category 3 wetland (1.73 acres), one Category 5 wetland (3.45 acres), and two Category 6 wetlands (187.63 acres).

USFWS (Slack, 2005) issued a Planning Aid Letter (PAL) to USACE on March 11, 2005, in which they provided guidance and recommendations on resource conservation issues for the EAA Reservoir Storage Project. USFWS recommended including a habitat buffer on the north and west sides, and littoral shelves along the seepage canals and on the internal sides of the embankment. USFWS recognized that littoral shelves on the interior sides of the EAA Reservoir A-1 may be cost-prohibitive.

2.7.1.2 Potential Impacts

Due to the presence of extensive sugarcane farming and limited acreage of natural habitats on the EAA Reservoir A-1 Project site, adverse effects to native vegetation are limited to wetland areas. As a result of the proposed EAA Reservoir A-1 Project, approximately 206 acres of emergent and scrub-shrub wetland will be converted to open water aquatic habitat. All impacts to upland areas are to lands in active agricultural use.

The existing wetlands (205.88 acres) within the EAA Reservoir A-1 Project are considered to be disturbed wetlands due to the sugarcane farming practices that comprise the majority of the surrounding area. Most of the wetlands are dominated by nuisance and/or exotic vegetation as identified by the Florida Exotic Pest Plant Council on the List of Invasive Species and appear to be isolated and surrounded by sugarcane farming. Although the habitat is predominately exotic, the wetlands still provide habitat and foraging for medium and small sized animals. The wetlands also provide water storage and promote water quality.

The proposed EAA Reservoir A-1 will replace the wetland habitat with an aquatic habitat that will be approximately 16,000 acres in size. The area is projected to re-vegetate through natural recruitment with aquatic plants and wetland plants particularly around the edge of the water. The aquatic habitat will provide habitat and foraging for medium and small sized mammals, reptiles, amphibians, birds, fish and invertebrates. The increase in open water will specifically provide an optimal location for migratory birds for habitat and foraging, and increased utilization by fish and other aquatic species. The water storage function will increase due to the large capacity of the EAA Reservoir A-1. There will be deep water refugia that will be approximately three to five percent of the total acreage. The EAA Reservoir A-1 will also provide a filter to “polish” water, improving water quality.

Littoral benches along seepage canals (approximately eight acres) will also be constructed around the exterior of the embankment. There may be intermittent littoral shelves within the canals, depending on the characteristics of the cap rock at specific locations. These littoral shelves will depend on natural vegetative recruitment from surrounding seed sources. The littoral shelves will also provide habitat and foraging for a variety of species, as well as water storage and increased water quality.

2.7.2 Fish and Wildlife

Prior to the agricultural alterations to this area, wildlife was similar to that found on the adjacent Holey Land WMA. Wildlife species typically seen at the Holey Land WMA include white-tailed deer, common snipe, marsh rabbit, blue-winged teal, mottled ducks, and other waterfowl.

2.7.2.1 Existing Conditions

The proposed EAA Reservoir A-1 Project area is dominated by sugarcane production interspersed with isolated emergent wetlands and drainage canals dissecting the property. The USFWS stated that native habitats for fish and wildlife are not a significant component of the area due to alterations for agriculture that have removed most native vegetation. The quality of habitat provided by the existing canal and wetlands is low. However, these wetland habitats do provide foraging habitat for birds, and the canals provide habitat for fish, reptiles, and invertebrates.

The Florida Natural Areas Inventory (FNAI) was consulted to identify the elemental occurrences of protected species within the EAA Reservoir A-1 Project area, and none was found. Potential habitat for the wood stork and Florida panther was identified southwest of the EAA Reservoir A-1 Project area that is in the Holey Land WMA. The FWC Potential Habitat Model was used by the USFWS to identify and calculate potential habitat areas for those wildlife species that may occur in the EAA Reservoir A-1 Project area. Out of 33 possible species, potential habitat was identified for 14. One of these is federally endangered (wood stork) and two are federally threatened (American alligator and eastern indigo snake).

2.7.2.2 Potential Impacts

Due to the limited natural habitat within the EAA Reservoir A-1 Project area, long-term adverse impacts to fish and wildlife, including state and federal protected species, are not anticipated. Waterfowl, fish, and reptiles may experience temporary impacts due to the elimination of existing agricultural ditches and isolated wetlands. Impacts to all wildlife species can be minimized by gradually flooding the area, thereby allowing the terrestrial wildlife to vacate the area. However, following construction, new habitat will be created that will afford similar foraging opportunities for these species. Potential habitat in the adjacent Holey Land WMA will be impacted indirectly by the control of water levels and improved water quality at the WMA. Additionally, temporary impacts from the noise from construction activities are anticipated.

2.7.3 Environmental Site Assessments

Under the Talisman Exchange, the Talisman Sugar Corporation (Talisman) in conjunction with The St. Joe Company (SJC), conveyed approximately 55,000 acres of land utilized for sugarcane farming and milling to the United States Department of Interior (DOI), the SFWMD and The Nature Conservancy (TNC). The farmland is located in Palm Beach and Hendry Counties, and consists of the Talisman Farm (approximately 36,000 acres) and several smaller, non-contiguous satellite farms.

The southern portion of the Talisman Farm will become EAA Reservoir A-1. The northern portion of the Talisman Farm, along with the satellite farms, has been exchanged by the SFWMD for land owned by other local sugarcane growers in order to secure a contiguous block of land necessary for creation of the EAA Reservoir A-1 and to assist in restoring water quality in the Everglades.

Prior to conveyance of the Talisman property, Dames and Moore (D&M), on behalf of the SFWMD, performed Phase I and Phase II Environmental Site Assessments on the Talisman owned/leased properties. The Environmental Site Assessments were part of the due diligence effort associated with the potential purchase of the property. The Phase I Environmental Site Assessment was performed to identify potential point source areas of concern. A Phase II Environmental Site Assessment was later performed to determine the status of potential constituents of concern (COC) at each of the areas of concern identified in Phase I. It was not within the scope of work of the Phase II Environmental Site Assessment to fully delineate any potential impacts to soil and/or groundwater.

Based on the Phase I and Phase II Environmental Site Assessments, D&M identified 11 areas at which COC were detected in soil, groundwater, sediment, or surface water at concentrations exceeding regulatory cleanup target levels or guidance concentrations. Transference of ownership of each of the Exclusion Areas was deferred until a Site Rehabilitation Completion Order (SRCO) for each Exclusion Area was issued by the FDEP.

The list of Exclusion Areas included:

- Five pump stations
- Two pesticide mix load areas
- A former labor camp and cropduster landing strip
- A former borrow pit/agricultural landfill
- The former sugar processing mill
- The surface water management areas adjacent to the sugar mill

These areas were primarily impacted with organochlorine pesticides (e.g., DDT), petroleum products, and arsenic.

Professional Services, Inc. (PSI) performed assessment and remediation on all of the Exclusion Areas on behalf of Talisman Sugar Corp. and the SJC. The cleanup objectives for each Exclusion Area within the proposed EAA Reservoir A-1 area were based on the proposed end land use for water storage areas. As such, cleanup target levels were chosen to be protective of potential ecological receptors which are likely to inhabit the area once a reservoir is constructed. Since the cleanup target levels for protection of wildlife for most of the chemicals found on the Talisman property are more stringent than the cleanup standards for human health, a cleanup to ecological standards is also inherently protective of agricultural workers during the interim period prior to EAA Reservoir A-1 construction, and EAA Reservoir A-1 construction workers.

The FDEP has issued SRCOs for the majority of the Exclusion Areas. These parcels can be conveyed immediately with no restrictions. On the remaining parcels, the remediation work has been completed to the satisfaction of the FDEP and the FDEP has issued memoranda of technical concurrence. However, a deed restriction is necessary in order to convey the property to SFWMD.

The cleanup of the mill site involved assessment and remediation of a number of point source discharge areas. Areas of concern at the mill site included numerous leaking petroleum storage tanks, pesticide and/or arsenic impacted soils in the sediments of two drainage canals, an ash pit, a water storage retention area, and metals-impacted soils adjacent to several building slabs.

In general, the petroleum impacted areas were handled through excavation and on-site treatment of soils in ex-situ bioremediation piles. Once the treatment was verified by confirmation sampling, the treated soils were returned to their respective excavations. PSI excavated, treated, and backfilled approximately 16,000 cubic yards of petroleum impacted soil at the mill site.

PSI were instructed that the canals and surface depressions at the mill are to be filled as part of the EAA Reservoir A-1 construction. Therefore, rather than excavating impacted sediments from the drainage canals, PSI elected to cover these slightly impacted soils with a 2-foot cover. The cover is intended to prevent exposure of potential receptor species to these sediments. Pesticide and arsenic impacted soil was also excavated from other areas of concern at the mill site and consolidated in the ash pit. The ash pit was a low lying excavated area that accepted effluent from the boilers. The ash in the pit was lightly impacted with heavy metals and polynuclear aromatic hydrocarbons (PAHs). Additional soils from other areas of concern were also filled into the pit and the ash pit was covered with two feet of clean soil to prevent future exposure.

These three areas within the mill site where contaminated soils have been left and capped will also require restrictions on excavation activities. These parcels are identified as the South Rock Canal, the Ash Pit, and the Waste Lake Discharge Ditch. An additional area of capped, impacted soil is present approximately three miles west of the mill at the former borrow pit/agricultural landfill. These areas contain pesticide, PAH and metal impacted soils which are buried beneath a clean soil cover. The excavation restrictions are necessary to prevent disturbance of these areas. These areas have been surveyed by a professional land surveyor and the coordinates have been provided to SFWMD personnel to ensure that no disturbance of these areas occurs.

In summary, all of the physical assessment and remediation intended by SFWMD has been completed on all of the Exclusion Area parcels and all of the technical documents relating to the cleanup have been reviewed and accepted by FDEP. Remaining outstanding activities are to record the appropriate deed restrictions on a few of the parcels. Once these activities are completed, it is expected that the FDEP will issue SRCOs on the remaining parcels and all of the parcels can be conveyed to SFWMD.

The Talisman Exchange and the environmental remediation described in the preceding paragraphs occurred before Black & Veatch's involvement with the project. SFWMD has verified that the variable water levels resulting from reservoir operation and subsequent resuspension of sediments were taken into account in the remediation assessment. Black & Veatch has been instructed that the SFWMD has accepted the standard of protection offered by the remediation. No further investigations into contamination are intended at this time. The Preliminary Design Report does not address any of these risks, and Black & Veatch accepts no responsibility of existing conditions as directed by the SFWMD.

3.0 DESIGN REQUIREMENTS AND CRITERIA

3.1 PROJECT LIMITS AND SITE DATUM

The EAA Reservoir A-1 Project is bounded by U.S. 27 on the east, STA-3/4 Inflow Canal on the south, STA Supply Canal adjacent to the Holey Land WMA on the southwest, and farmland in the EAA to the northwest and north.

The horizontal datum for this report is North American Datum of 1983 (NAD83); and vertical datum is North American Vertical Datum of 1988 (NAVD88). Some other studies and designs use the National Geodetic Vertical Datum of 1929 (NGVD29) as a vertical datum. The relationship between them is NAVD88 = NGVD29 – 1.4 feet.

3.2 FUNCTIONAL AND OPERATIONAL

3.2.1 Inflow to EAA Reservoir A-1

EAA Reservoir A-1 inflows will consist of flows from the NNRC, Miami Canal, seepage collection canals, and precipitation. A more detailed description of each inflow is provided in Section 6.2.4 of the BODR.

Inflow will be accomplished through the use of the new northeast pump station and gate structures from the STA-3/4 Inflow Canal.

3.2.2 Discharge from EAA Reservoir A-1

EAA Reservoir A-1 discharges will consist of losses from evaporation, seepage, environmental deliveries, agricultural deliveries, and excess volume outflows. A more detailed description of each discharge is provided in Sections 6.2.5 and 6.2.6 of the BODR.

Releases from the EAA Reservoir A-1 will be made from the STA-3/4 Inflow Canal gate structures, gate structures and spillway adjacent to the northeast pump station, and pumped discharges from the northeast pump station.

3.2.3 Water Quality

The EAA Reservoir A-1 is intended to function as a water impoundment and flow equalizing reservoir. Any water treatment value as a result of impoundment is entirely coincidental. However, the EAA Reservoir A-1 will fall under CERP Level 2 requirements, which state that the EAA Reservoir A-1 will not contribute to the degradation of water quality releases. Of primary interest is the fate of phosphorus entering the EAA Reservoir A-1 from the NNRC and Miami Canal.

Modeling by the Dynamic Model for Stormwater Treatment Areas (DMSTA) concluded that the EAA Reservoir A-1 will not negatively impact water quality in the EAA. It estimated that the EAA Reservoir A-1 would achieve an average 17 percent reduction in the phosphorus loading from the canals.

Details of the water quality modeling of the EAA Reservoir A-1 are provided in the BODR (Appendices 3-2 and 3.3).

3.3 SERVICE LIFE

According to USACE Engineering Manuals EM-1110-2-3104, EM-1110-2-3102, and Major Pumping Station Engineering Guidelines, the design life for the new northeast pump station and any modifications to G-370 and G-372 pump stations will be 50 years. With proper maintenance, this design life can be achieved by following the guidance in these documents.

Design of the pump station, equipment, or other pump station systems is not included in the scope of this document.

3.4 PROJECT WORK LIMITS

The EAA Reservoir A-1 Project limits are bounded by the Florida Department of Transportation (FDOT) Right of Way (ROW) adjacent to U.S. 27 on the east, STA-3/4 on the south, the Holey Land WMA on the southwest, and farmland in the EAA on the northwest and north. A survey of some of the cross-sections along the boundary of the EAA Reservoir A-1 was completed in 2004 (Wantman Group, 2004). Any need for additional surveying will be evaluated during the preliminary design. Final surveys for the EAA Reservoir A-1 components may be completed when the approved facility locations have been finalized.

3.5 UNITS

The units and system of measurement will be in English.

3.6 CODES AND STANDARDS

3.6.1 General

- CERP Guidance Memoranda
- SFWMD Design Criteria Memoranda
- SFWMD Standard Design Guidelines adopted August, 2005
- Acceler8 Design Criteria Memoranda (DCM)

3.6.2 Site Work Design Criteria

Codes and standards: design and specification of all work shall be accordance with latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein.

- American Association of State Highway and Transportation Officials (AASHTO)
- American National Standards Institute, Inc. (ANSI)
- American Society for Testing and Materials (ASTM)
- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)

- Asphalt Institute (AI)
- Federal Highway Administration (FHWA)
- Florida Department of Transportation (FDOT)
- Manual on Uniform Traffic Control Devices (MUTCD)
- South Florida Water Management District (SFWMD)
- Uniform Federal Accessibility Standards (UFAS)
- United States Army Corps of Engineers (USACE)

3.6.3 Geotechnical Design Criteria

Codes and Standards: Design and specification of all work shall be in accordance with latest laws and regulations of the federal government, with applicable local codes and ordinances, and with codes and industry standards referenced herein. Following is a summary of organizations with codes and standards referenced herein. Recommended and recognized standards from other organizations shall be used where required and approved to serve as guidelines for the design, fabrication, and construction when not in conflict with the standards referenced herein.

- American Society for Testing and Materials (ASTM)
- Design Manual for Roller Compacted Concrete (RCC) Spillways and Overtopping Protection, Portland Cement Association, 2002
- Engineering Manual (EM) 1110-2-2300, General Design and Construction Considerations for Earth and Rock-Fill Dams
  - EM 1110-2-1901, Seepage Analysis and Control For Dams
  - EM 1110-2-1902, Slope Stability
  - EM 1110-2-2006, Engineering Design – Roller Compacted Concrete
- Florida Building Code, 2004 Edition
- Florida Department of Transportation (FDOT)
- South Florida Water Management District (SFWMD)
- United States Army Corp of Engineers (USACE)

3.6.4 Design Criteria Memoranda

Following is a summary of the Design Criteria Memoranda and their respective issue dates.

• DCM-1	Hazard Potential Classification	August 19, 2005
• DCM-2	Wind and Precipitation Design Criteria for Freeboard	October 11, 2005
• DCM-3	Spillway Capacity and Reservoir Drawdown Criteria	August 19, 2005
• DCM-4	Minimum Dimensions of Dams and Embankments	August 19, 2005
• DCM-5	Major Pump Station Engineering Guidelines	In Progress

- DCM-6 Geotechnical Seismic Evaluation of CERP Dam Foundations — May 16, 2005
- DCM-7 Procedure for Development of Engineering Construction Cost Estimates — August 5, 2005
- DCM-8 Vulnerability Protection Requirements — In Progress
- DCM-9 Embankment Instrumentation — In Progress
- DCM-10 Construction Quality Assurance Procedures — In Progress
- DCM-11 Post Construction/Inspection/Dam Safety Program — In Progress
- DCM-12 Value Engineering — In Progress

4.0 AMENDMENT TO BASIS OF DESIGN REPORT (BODR)

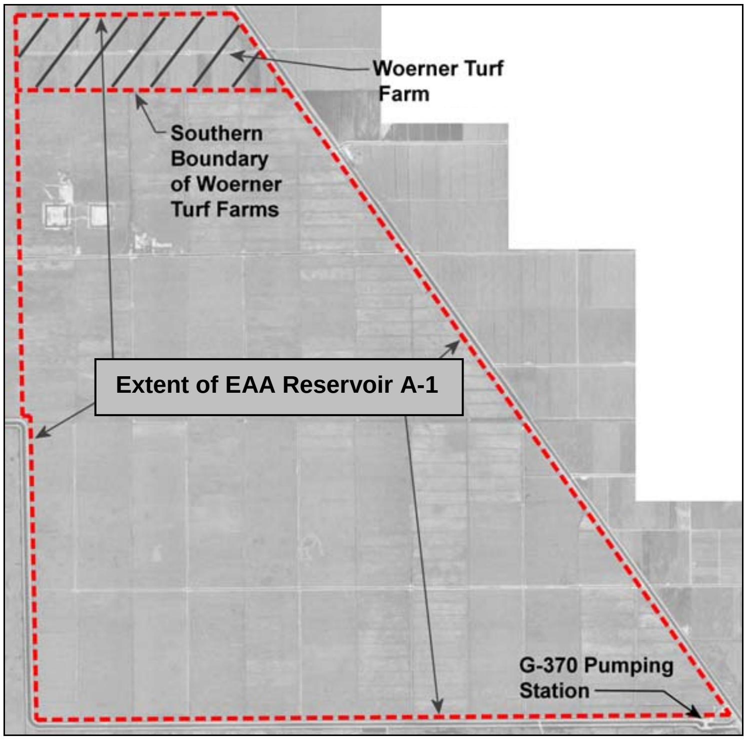
This Section describes changes in the design or documentation that have been made since the BODR was submitted. There are six amendments to the BODR:

- A change in the embankment alignment, which is described in the following pages
- A change in embankment seepage control, as described in this Section
- Project Assurances, which follow this Section
- RCC and Soil Cement Design Mixes Technical Memorandum, which follows this Section as Task 16.15, Appendix 8-25 of the BODR
- Draft Project Operating Manual, which is described in Section 7
- Opinion of Probable Cost, which will be submitted as a separate document

4.1 REALIGNMENT OF THE EMBANKMENT

In late 2005 and early 2006, reports were prepared for the SFWMD by Professional Service Industries, Inc. (PSI) describing toxaphene risk assessment for the Woerner Turf Farm, which is located within the boundaries of the EAA Reservoir A-1 Project. The Woerner Turf Farm covers approximately the northernmost 3,500 feet of the EAA Reservoir A-1 tract. This is illustrated in Figure 4.1-1. Despite mitigation efforts, low levels of toxaphene remain in the muck at this site. There is a potential concern with the remaining low levels of toxaphene if the area is inundated as a result of the filling of the EAA Reservoir A-1. This concern involves the migration of toxaphene into the food chain if fish that are feeding off the bottom of the EAA Reservoir A-1 in the area of the former Woerner Turf Farms are consumed by wading birds.

Figure 4.1-1 Woerner Turf Farm Area



4.1.1 EAA Reservoir A-1 Configuration

Several alternatives were evaluated to address the contamination issue. One alternative was to remove and dispose of all muck in this area and retain the embankment alignment identified in the EAA Reservoir A-1 BODR prepared by Black & Veatch January, 2006. The opinion of probable cost of excavation and stockpiling of this muck is estimated at $16,500,000. It is expected that disposal costs would be considerably more than the cost of excavation because there is little open area left in the EAA Reservoir A-1 parcel to place the excavated material and therefore, considerable transportation distances will be required.

Another alternative was to change the current EAA Reservoir A-1 configuration. In this option, the north boundary of the EAA Reservoir A-1 would be relocated approximately 2,530 feet south so that the limits of muck removal required for construction of the embankment and associated canals would end at the extent of the Woerner Turf Farms tract. The embankment reconfiguration is illustrated in Figure 4.1-2 and Figure 4.1-3.

A third alternative was to move the project limits completely south of the Woerner Turf Farms tract. For this option, the northern embankment would move approximately 3,420 feet south so that the northern edge of the seepage canal would be constructed at the edge of the contaminated muck. Therefore, no additional handling of muck would be necessary, and all of the Woerner Farms Tract would remain unused.

Figure 4.1-2 EAA Reservoir A-1 Re-configuration

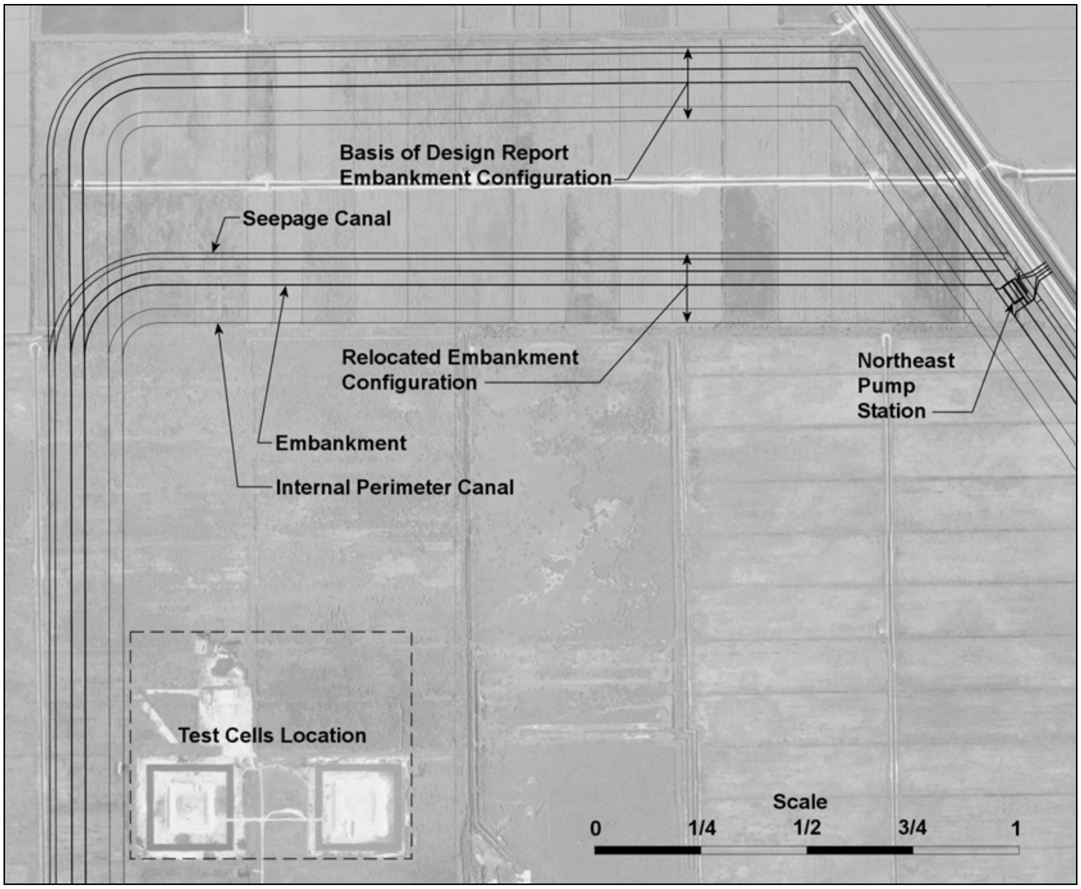
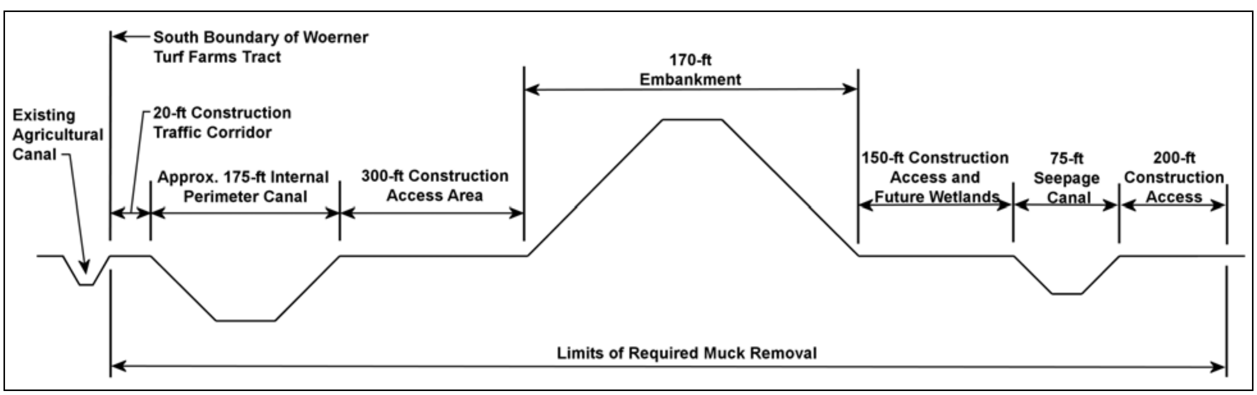


Figure 4.1-3 Setbacks for Woerner Farms Re-configuration



4.1.2 EAA Reservoir A-1 Volume

If the configuration of the EAA Reservoir A-1 is modified, the minimum volume requirement of 190,000 acre-feet of potential storage would no longer be met at a depth of 12 feet. As shown in Table 4.1-1, it was determined that the necessary depth to attain 190,000 acre-feet of potential storage with the re-configured EAA Reservoir A-1 is 12.4 feet to 12.6 feet depending on which re-configuration option is selected. As discussed in Section 5 of the BODR, the minimum embankment height to impound wave run-up and wind set-up for a depth of 12 feet is 25.5 feet. The embankment height used for the cost opinion was 26 feet above natural ground, 0.5 feet greater than the wave run-up and wind set-up analyses required. Although the additional 0.4 to 0.6 feet of embankment height required for the re-configuration would negate the 0.5 feet factor of safety, no additional increase in embankment height would be required.

Potential benefits of re-configuration of the EAA Reservoir A-1 include the following:

- Minimizes the potential toxaphene risk
- Reduce the overall embankment length by 3,800 to 5,200 feet with a subsequent cost reduction of approximately $14,000,000 to $24,000,000
- Increased buffer zone between the EAA Reservoir A-1 and the agricultural areas immediately north
- Potential additional areas made available for wetlands. (This would, however, require additional muck removal.)

If the embankment is moved to the area immediately north of the southern Woerner Turf Farms tract (listed in Table 4.1-1 as Option 1), muck must be removed from this area and would need to be stockpiled and used on the outside face of the embankment or evenly spread over areas outside of the construction zone. This would require the depth of topsoil on the exterior face to be slightly more than two feet thick. Additional cost associated with transport of this material would be about $30,000,000. Option 2 in Table 4.1-1 is the alternative which moves the Project limits completely south of the Woerner Turf Farm tract.

Table 4.1-1 Configuration/Volume Relationships

Configuration	Inside Area of Reservoir (acre)	Maximum Pool Depth (feet)	Reservoir Volume (ac-ft)
Basis of Design Report Configuration	15,870	12.0	191,000
Woerner Turf Farms Setback – Option 1	15,270	12.4	190,000
Woerner Turf Farms Setback – Option 2	15,030	12.6	190,000

4.1.3 Conclusion

As the minimum volume can be attained at the current embankment height design, the impact of re-configuration will not be affected by meeting minimum volume requirements. However, other design parameters will be affected by the decision to re-configure. For example, spillway and pump station design parameters set forth in the BODR would need to be updated. Additionally, any work already performed based on the BODR configuration would need to be updated or re-performed. This could include survey work and geotechnical efforts such as borings. Finally, a timely response to these issues at hand is extremely important as detailed design for the EAA Reservoir A-1 embankment has begun and detailed design on canals will commence soon.

4.2 SEEPAGE CONTROL

4.2.1 Cutoff Wall Depth

Supplementary borehole information has been compiled since the BODR was produced. The new borehole information has been transferred to longitudinal sections around the perimeter of the EAA Reservoir A-1 as shown in Section 12. A Limestone Zone is present within the lower portion of the Fort Thompson Formation in 23 of the perimeter borings. At the Test Cell site a similar condition was recorded. The lower Limestone Zone was found to be relatively thin in some perimeter areas of the Test Cell site and was penetrated by the backhoe used to excavate the trench. In other areas the cutoff wall was terminated on top of the limestone.

Approximately half of the logged occurrences around the perimeter are scattered without continuity between boreholes. The boreholes in which this zone was defined are widely spaced around the perimeter, often more than 3,000 feet apart. The logged occurrences of the lower Limestone Zone are also shown in Table 4.2-1.

As shown in Table 4.2-1, the top elevation of the more prominent lower Limestone Zones has been recorded as high as elevation -1.5 and a lowest elevation of -28.1. The thickness of the identified zone was found to vary from a minimum 2 feet to a maximum of 15 feet. Records of SPT N or core recovery and RQD from the zone are shown in Table 4.2-1. Where the tests were carried out, N value was higher than 50 with minimal penetration. Core recovery averaged approximately 60 percent with average RQD 30 percent. The maximum values were 96 percent recovery with a corresponding RQD of 64 percent. The recorded values of core recovery and RQD suggest possible difficulty in achieving a common elevation of -24 for the bottom of the wall. The actual bottom of the wall to be achieved in construction will be defined using performance criteria.

Table 4.2-1 Limestone Zone within Fort Thompson Formation

Sr. No.	Boring Number CP05-EAARS-CB-0	Depth (feet)		Elevation (feet)		Thickness (feet)	Recovery (percent)	RQD (percent)	SPT N value
		Top	Bottom	Top	Bottom				
1	258	38.5	43.5	-28.1	-33.1	5	na	na	50/3"
2	268	28.5	32.5	-20.3	-24.3	4	na	na	50/2"
3	269	23.5	32.2	-12.9	-21.6	8.7	na	na	50/2"
		28.5					na	na	50/2"
4	270	23.5	38.5	-13.1	-28.1	15	na	na	50/1"
		28.5					na	na	50/1"
		33.5					na	na	50/0"
5	271	28.5	33.5	-17.8	-22.8	5	na	na	50/2"
6	274	18	22	-4.4	-8.4	4			na
7	275	18.5	23.5	-10	-15	5	na	na	50/0"
8	280	22.5	25	-13.8	-16.3	2.5	na	na	50
9	290	36	39	-25.5	-28.5	3	na	na	50/1"
10	291	22.5	24.5	-11.9	-13.9	2	na	na	50/1"
11	293	37	42	-25.3	-30.3	5	92	47	na
12	310	30	35	-20	-25	5	56	24	na
13	312	23.5	31.5	-11.1	-19.1	8	40	0	na
		28.5					66	14	na
14	313	23.5	30	-12	-18.5	6.5	68	52	na
15	314	25	35	-14.1	-24.1	10	60	48	na
		30					96	64	na
16	315	27	29.5	-15.4	-17.9	2.5	na	na	50
17	316	20.5	35.5	-9.9	-24.9	15	56	27.5	na
		25					76	49	na
		30					65	15	na
18	323	17.7	21	-6.2	-9.5	3.3	74	40	na
19	324	16	27.5	-5.3	-16.8	11.5	82	56	na
		21					32	8	na
20	326	17.5	28	-6.4	-16.4	10.5	80	52	na
		22.5					36	0	na
21	327	18	28	-7.1	-17.1	10	78	28	na
		23					44	16	na
22	330	9.8	15	-1.5	-6.7	5.2	12	0	na
23	407	28.5	38.5	-15.4	-25.4	10	28	14	na
		33.5					74	48	na
	Average		30.9	-13.37	-20.16	6.81			
	Max		43.5	-1.5	-6.7	15			
	Min		15	-28.1	-33.1	2			

4.2.2 Cutoff Wall Composition

The caprock and other potentially open layers within the Fort Thompson Formation represent areas where high hydraulic gradients could exist across the wall; i.e. surcharged pool pressures applied to the upstream side with minimum seepage canal level on the downstream side. Open areas of caprock are potential conduits through which piping may develop through a soil bentonite wall from the downstream side.

Settlement of soil bentonite backfill within the trench excavated through relatively stiff material could lead to reduced vertical stress within the wall material. In these circumstances a phenomenon called hydro-fracture is possible when the vertical confining stress is exceeded by the hydraulic pressure at that point. In those conditions a fissure is able to open, causing loss of water and, potentially, erosion of the bentonite slurry material leading to piping of the water retaining random fill zone above.

The risks of piping and hydro-fracture are eliminated by using a cement-bentonite backfill material. This is common practice and is the method currently employed by USACE for the cutoff wall construction for remediation of the Hoover Dike around Lake Okeechobee.

4.2.3 Chimney Drain/Filter

In the typical cross-section of embankment, which applies to the Northwest, North and East sides of the EAA Reservoir A-1, the central raked random fill water retaining zone sits directly on caprock. Downstream of the cutoff wall there is potential for material to pipe down into continuous voids in the caprock layer. Such piping could potentially develop to the extent that it threatened embankment integrity and the risk should therefore be eliminated. The chimney drain, which contains a material that is in filter relationship with the random fill, has been extended in trench to the base of the caprock layer. This feature effectively cuts off the potential pathways in the caprock layer preventing migration of fines.

4.2.4 Transition Layers

The rockfill produced on site will be of variable grading even within the specified limits due to the variability of the caprock base material. There is potential for voids and open areas between rock particles. With fluctuating water levels and even simply gravity, there is potential for fines from the central raked random fill zone to migrate into the rockfill. This phenomenon can be the cause of settlement and occasional sinkholes, as has been reported in the crest of Hoover Dike around Lake Okeechobee. The potential for migration of fines is eliminated by inclusion of a graded transition layer between the zones.

4.2.5 RCC Wave Protection Bedding Layer

The lower portion of the RCC wave protection is to be placed against rockfill. Rockfill material will be of variable composition with some open areas particularly around larger rocks. A bedding layer is included in the design to smooth the surface of the rockfill and provide a firm bed against which to place and compact the RCC flat-plate wave protection.

4.3 PROJECT ASSURANCES

With the exception of flood protection assurances, the Project Assurances document following this Section was prepared by the Acceler8 team in support of project assurances. Section paragraphs, tables, and figures have been renumbered to correspond to the EAA Reservoir A-1 Embankment and Canals Preliminary Design Report format.

PROJECT ASSURANCES

1.0 INTRODUCTION

The EAA Reservoir A-1 Preliminary Design Report for the Everglades Agricultural Area (EAA) Storage Reservoir Project recommends a plan in Palm Beach County that is designed to capture, store and redistribute freshwater previously lost to tide and to regulate the quality, quantity, timing and distribution of water flows. Additional storage in the project area is needed to reverse declines in ecological function and productivity in Lake Okeechobee and the estuaries of the Caloosahatchee River and St. Lucie Canal. The overall objectives of the EAA Storage Reservoir A-1 project are to improve the timing of environmental deliveries to the Water Conservation Areas (WCAs), including reducing damaging flood releases from the Everglades Agricultural Area; reducing Lake Okeechobee regulatory releases to the estuaries; meeting EAA irrigation and Everglades water demands; and providing incidental flood protection in the EAA. Constructing and operating the EAA Reservoir A-1 would reduce water demands from Lake Okeechobee, reduce the need to back-pump EAA storm water to the Lake, and reduce the damaging pulsed regulatory releases from Lake Okeechobee to the Caloosahatchee River and St. Lucie Canal. This should enhance habitat function and quality in Lake Okeechobee's littoral zone, the WCAs and the Caloosahatchee River and St. Lucie estuaries (the northern estuaries), and improve native plant and animal species abundance and diversity by retaining natural waters in the system. Benefits to the downstream estuaries are expected as a result of reduction in abrupt and high-volume fresh water flows and pulsed releases from Lake Okeechobee.

2.0 REASONABLE ASSURANCES FOR ACCELER8 PROJECTS

Although Florida State statutes (F.S) require analyses in the Draft Project Implementation Report for the EAA Storage Reservoir, theses analyses are provided as supplemental information for the Acceler8 preliminary design report. The types of analyses provided herein are described below.

Section 373.1501(5)(d), F.S. states that the SFWMD shall "Consistent with this Chapter, the purpose for the restudy in the Water Resources Development Act of 1996, and other applicable federal law, provide reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project so as to adversely impact existing legal users, that existing levels of service for flood protection will not be diminished outside the geographic area of the project, and that water management practices will continue to adapt to meet the needs of the restored natural environment."

Section 373.470(3)(c), F.S. states that "Each project implementation report shall also identify the increase in water supplies resulting from the project component. The additional water supply shall be allocated or reserved by the District under Chapter 373."

2.1 Water Supply Assurance

This section is intended to provide sufficient information for providing "reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users, . . ." Section 373.1501(5)(a), F.S. Pursuant to Section 373.219, Florida Statutes, existing legal users are those that have a consumptive use permit or are exempt from permitting requirements, such as domestic users. Section 373.2223(4), F.S. requires that when establishing a water reservation for protection of fish and wildlife, existing legal users "be protected so long as such use is not contrary to the public interest."

These requirements necessitate a quantification of the amount of water permitted to all existing legal users, used by exempt users or protected through settlement agreements between the Seminole Tribe of Indians of Florida and the SFWMD affected by the EAA Reservoir A-1 project. This quantification is included in the existing condition PIR baseline model run which is compared to the selected alternative plan to examine the potential impact of the Acceler8 project on the quantity and quality of water for the existing legal users.

To identify project effects, the regional water management system including the operations of the EAA Reservoir A-1 project is simulated with the regional model, South Florida Regional Water Management Model, version 5.4. Modeled outputs are compared to those produced for the Existing Condition in 2005. Table 2.1-1 lists the existing legal users potentially affected by the EAA Reservoir A-1 project and their sources.

Table 2.1-1 Existing Legal Users Potentially Affected by the EAA Reservoir A-1 Project

Existing Legal Users	Source
Lake Okeechobee Service Aarea, including Everglades Agricultural Area	Lake Okeechobee; local basin storage and runoff
Urban Water Supplies: Lower East Coast	Lake Okeechobee, local basin storage and runoff; surficial aquifer
Urban Water Supplies: C-44 Canal/St. Lucie Basin	Lake Okeechobee; local basin storage and runoff; surficial aquifer
Urban Water Supplies: C-43 Canal/Caloosahatchee Basin	Lake Okeechobee; local basin storage and runoff; surficial aquifer
Seminole Tribe of Florida (Big Cypress Reservation)	Lake Okeechobee; local basin storage and runoff; surficial aquifer
Miccosukee Tribe of Indians of Florida (WCA 3 and Everglades National Park)	Lake Okeechobee; local basin storage and runoff
Exempt Domestic Users	varies

2.1.1 Hydrologic Model Simulations

Two different operational plans were modeled to evaluate project assurances and Savings Clause requirements (see Table 2.1-2). A volume envelope approach was used in the hydrologic simulation modeling to determine the range of volumes that the EAA Reservoir A-1 project is capable of delivering to meet environmental demands and for the other water-related needs of the south Florida region.

Table 2.1-2 Model Simulations

Simulation Name	Explanation	Description
ExPIR	Existing Condition PIR Baseline	2005 Baseline condition for State of Florida existing legal users evaluation
EAA-NoRDO	Existing Condition –With Project	Conservative with-project simulation (EAA Reservoir A-1 operated to act as a surge tank for Lake Okeechobee releases) performed for comparison to baselines to evaluate project effects; WCAs operated per regulation schedules.
EAA-RDO	Existing Condition – With Project	Potentially optimized with-project simulation performed for comparison to baselines to evaluate project effects; environmental deliveries to WCAs and ENP per rainfall-driver triggers

The EAA-RDO model run represents a potentially optimized operational scenario whereby water can be prospectively delivered out of the EAA Reservoir A-1 based on a series of rainfall-based (aka rain driven operations – RDO) environmental targets in the Water Conservation Areas and Everglades National Park while still maintaining Existing Conditions water supply performance.

The EAA-NoRDO model run represents a more conservative operational scenario, whereby the EAA Reservoir A-1 is operated primarily as a surge tank for the storage of regulatory releases from Lake Okeechobee and EAA runoff, and water is delivered out of the EAA Reservoir A-1 primarily to ensure, at a minimum, that Existing Conditions water supply performance (including agriculture, urban and fish and wildlife and Everglades National Park) is achieved as a result of project implementation. The regulation schedules are in effect in the WCA's and not rain driven operation (No-RDO).

2.1.2 Urban and Agricultural Water Supply

Existing legal users of water supply for urban and agricultural uses of water likely to be affected by implementation of the EAA Storage Reservoir A-1 include users in the Lake Okeechobee Service Area (LOSA), which includes EAA, the C-43 (Caloosahatchee) Basin, the C-44 (St. Lucie) Basin, as well as L-8, S-4, S-236 Lower Istokpoga, North and Northeast Lake Shore Basins and 298 Districts surrounding the Lake. In addition to LOSA, existing legal users include the North Palm Beach Service Area, and Lower East Coast Service Areas 1, 2, and 3. As would be expected through the construction and operation of an impoundment capable of storing approximately 190 k acre-feet of water, implementation of the project will increase the quantity of water available to meet agricultural and urban water supply demands. The following sections summarize project effects on users of water for agricultural and urban water supplies in the project area, which are based on operations closer to existing conditions (EAA-NoRDO). In the other operating scenario (EAA-RDO), water is delivered to WCA's and ENP when available to meet natural system demands. The EAA-RDO model simulation was not optimized for this condition and resulted in one additional water supply restriction event when Lake Okeechobee stages fell into the Supply-Side Management zone. During actual operations, deliveries south to the WCA's and ENP would be moderated to avoid these low Lake levels.

Everglades Agricultural Area - Due to the reduction in demand for supplemental irrigation associated with the conversion of agricultural lands within the Everglades Agricultural Area (including the footprint of the EAA Reservoir A-1 project), the overall demand for supplemental irrigation in the Everglades Agricultural area is reduced from annual average of 348 k ac. ft. in the Existing Conditions to 331 k ac. ft. (EAA-NoRDO) as a result of project implementation.

Compared to Existing Conditions volumes, the EAA Storage Reservoir A-1 project will reduce the volume of unmet demand for supplemental irrigation in the Everglades Agricultural Area by approximately 12.0 k ac. ft., from 25 k ac. ft. to 13 k ac. ft. (36-year annual averages). This represents a percentage reduction of approximately 4.0 percent.

This overall improvement toward meeting demands for supplemental irrigation is accomplished by reducing the volume of water delivered from Lake Okeechobee to meet irrigation demands from an annual average volume of approximately 323 k ac. ft. to 217 k ac. ft., while providing an average of 101 k ac. ft. for irrigation from the EAA Reservoir A-1 itself (period of record).

Other Areas of Lake Okeechobee Service Area - Compared to Existing Conditions quantities, modeling results indicate that the EAA Reservoir A-1 project will reduce the average annual volume of unmet demands for supplemental irrigation from Lake Okeechobee to supply areas of Lake Okeechobee Service Area other than EAA (namely, S-4, S-236, L-8, Lower Istokpoga, North and Northeast Lake Shore Basins plus 298 Basins) from 5.5 percent to 4.3 percent for the EAA-NoRDO model simulation. For these portions of LOSA, the project will reduce the volume of unmet demands (water year) from approximately 5 k ac.-ft. (Existing Conditions) to less than 4 k ac.-ft (EAA-NoRDO).

C-43 (Caloosahatchee) Basin - Modeling results indicate that on average annually, the project will reduce the volume of unmet demand for supplemental irrigation in the C-43 Basin (4.5 percent; approximately 5 k ac.-ft.) compared to the Existing Condition volume (5.8 percent; approximately 6.4 k ac.-ft.).

C-44 (St. Lucie Canal) Basin - For the C-44 Basin, modeling results indicate that the project will result in a decrease from the Existing Conditions level of unmet demand for supplemental irrigation (6.4 percent; approximately >1 k ac.-ft) to 4.8 percent.

North Palm Beach and Lower East Coast Service Areas - Based on modeling results, implementation of the EAA Reservoir A-1 project will improve water supply performance in the North Palm Beach Service Area and Lower East Coast Service Areas 1 (central and southern Palm Beach County), 2 (Broward County) and 3 (Miami-Dade County), although the project effects are least significant in Service Area 2. In particular, although Lake Okeechobee stages are lower on average (thereby improving in-lake habitat conditions), storage of Lake Okeechobee discharges and runoff from the Everglades Agricultural Area by the project creates additional capability for Lake Okeechobee to provide water supply deliveries to these areas. Project implementation is also predicted to result in fewer months experiencing water supply cutbacks and, either no effect, or a reduction in the volume of cutbacks for public water supplies all service areas; results are summarized in Table 2.1-3.

Table 2.1-3 Number of Years with a Restriction Event and Total Number of Months of Restrictions in 36 year Simulation

	2005 Existing Condition (ExPIR)		**2005 Existing Condition with EAA Storage Reservoir (EAA-NoRDO)**	
Service Area	**Number of Years**	**Total Number of Months**	**Number of Years**	**Total Number of Months**
LOSA	9	25	4	7
LECSA 1	6	39	4	29
LECSA 2	24	128	24	127
LECSA 3	5	36	3	25
North Palm Beach SA	5	34	3	24

The results of this comparative analysis indicate the quantity of water for the existing legal users within the EAA Reservoir A-1 Project boundary will not be diminished. Based upon this information, the SFWMD is providing reasonable assurances that the quantity of water available to existing legal users shall not be diminished by implementation of project components so as to adversely impact existing legal users.

2.2 Flood Protection Assurance

The primary purpose of the Project is to store runoff from the EAA and discharges from Lake Okeechobee to improve ecological functions in Lake Okeechobee, the St. Lucie and Caloosahatchee Estuaries, and the EPA. The storage of up to 190,000 acre-feet of water in an above ground EAA Reservoir A-1 operated at a normal above ground pool depth of 12 feet will incidentally improve flood protection by removing 16,700 acres from the drainage basin. The EAA Reservoir A-1 may be expected to increase average elevations of groundwater in adjacent lands unless appropriate flood mitigation measures are included as part of project implementation. Sub-regional hydrologic modeling has been conducted using the MODFLOW (a three-dimensional groundwater flow model) and SEEP/W (a two-dimensional finite element model) to determine the project's effects on the level of service for flood protection in 2005.

An initial evaluation of potential project effects has been conducted for the Project using the MODFLOW model. The results of the initial evaluation indicate that the Project may increase groundwater elevations in portions of STA 3/4 adjacent to the Project and in a small area of the Holey Land WMA. A slight increase in groundwater elevations beneath STA 3/4 is not expected to adversely affect water quality treatment functions of that project and can be further managed by project surface water operations considering these groundwater deliveries. The effects within the Holey Land WMA are confined to within approximately 500 to 1000 feet of the EAA Reservoir A-1 project footprint, and are not expected to adversely affect fish and wildlife habitat and recreational use functions of that area and can be further managed by project surface water operations considering these groundwater deliveries.

The project includes a 150-200 foot buffer area surrounded by a seepage collection canal including seepage return pumps to manage seepage within the project footprint. Due to the inclusion of this feature, the initial evaluation did not indicate that there was an effect on groundwater elevations in agricultural lands north of the Project site beyond the Project footprint due to the southeasterly gradient of groundwater in this area. Project engineers have recommended including a cutoff wall beneath the levee to provide additional stability and seepage control. The cutoff wall would provide additional control of seepage resulting from the hydraulic head created by the storage of water in the EAA Reservoir A-1. This feature is included in the cost estimate for the selected alternative plan. Due to the location of the proposed buffer and seepage collection system west of the FDOT right-of-way for U.S. 27 and the results of the preliminary hydrologic and hydraulic modeling analyses to date, which indicate that the proposed EAA Reservoir project is not expected to result in increased water levels in adjacent canal systems, the EAA Reservoir A-1 Project is not expected to adversely impact the integrity of U.S. 27.

A summary of the effect on groundwater levels in the vicinity of the Project due to operation of the EAA Reservoir A-1 is included on Figure 2.2-1.

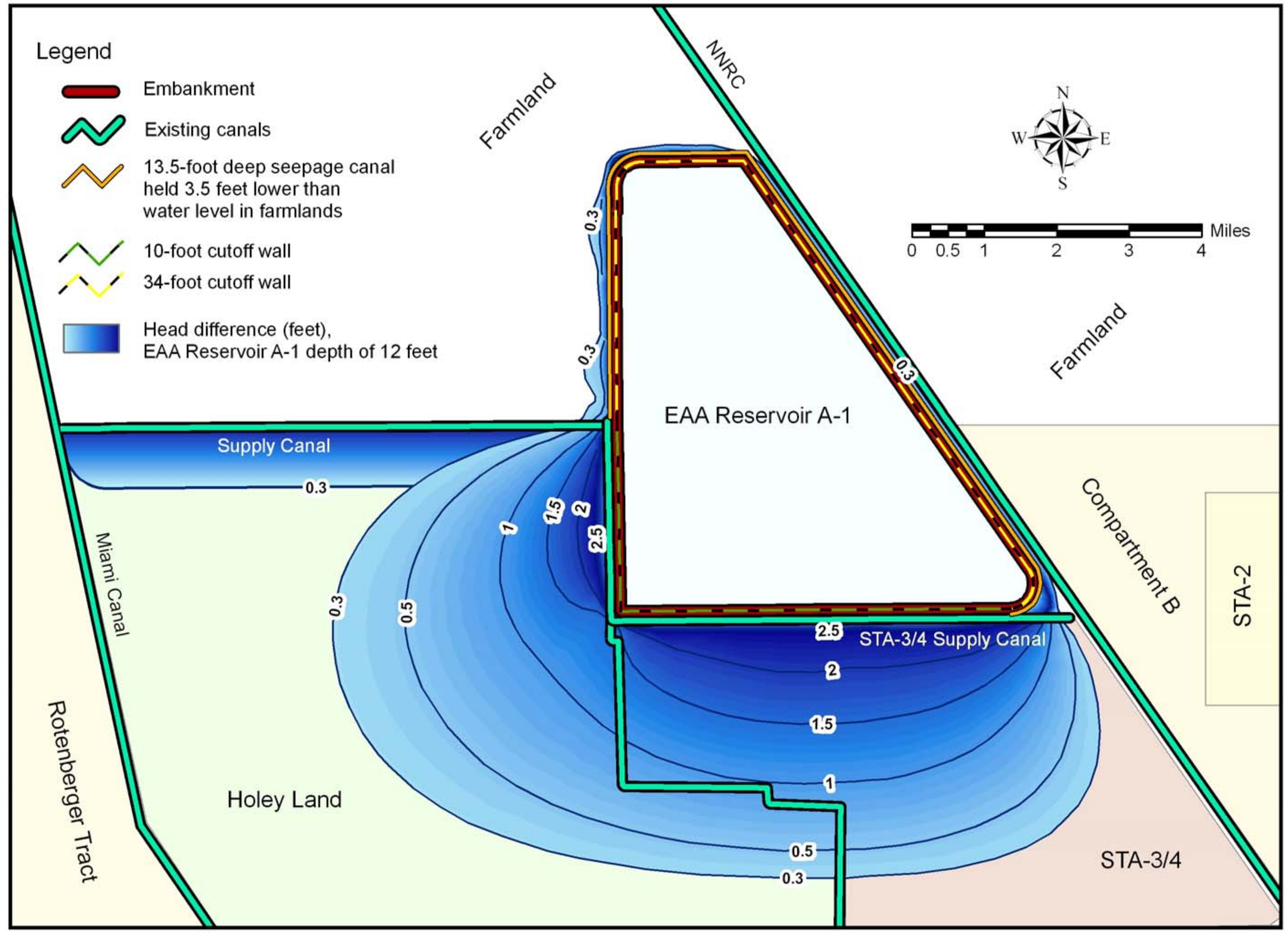
Figure 2.2-1 Final Selected Seepage Mitigation Plan along with Maximum Offsite Water Level Changes with a 12 Foot Pool in EAA Reservoir A-1

Configuration:

- EAA Reservoir A-1 at full depth of 12 feet
- 34-foot cutoff wall and seepage canal around northwest, north, and east sides of EAA Reservoir A-1; 10 foot cutoff and no seepage canal along STA-3/4 and Holey Land
- Seepage canal held 3.5 feet below farm water levels. Assumes STA and Holey Land are not operated to offset the rise in groundwater levels

Results:

- This alternative keeps rise in groundwater levels in farms less than 0.3 feet
- This alternative causes a rise in groundwater levels of up to 2.5 feet in STA-3/4 and Holey Land. Keeps groundwater at acceptable levels beneath U.S. 27. Some seepage will migrate to the Holey Land during periods of the year when the water level in the Supply Canal is elevated to fill the EAA Reservoir A-1. Seepage to the north of the Supply Canal will be controlled by an existing seepage canal
- Total EAA Reservoir A-1 seepage = 346 cfs (only when EAA Reservoir A-1 is full)
- Seepage canal collects 290 cfs
- Total additional volume to STA-3/4 is approximately 10,900 acre-feet per year with a maximum additional flow rate of approximately 29 cfs when Supply Canal is floated to 8 feet
- Net additional volume to the Supply Canal is approximately 30,100 acre-feet per year. Maximum flow into Supply Canal is approximately 84 cfs when EAA Reservoir A-1 is full of water. Maximum flow out of Supply Canal to surrounding areas is approximately 60 cfs when Supply Canal is floated to 8 feet.
- Total additional volume to Holey Land is approximately 9,900 acre-feet per year with a maximum additional flow rate of approximately 39 cfs when Supply Canal is floated to 8 feet
- Seepage control cost for Alternative 3 = $64,590,000



3.0 *INCREASED WATER SUPPLY AVAILABLE FROM PROJECT*

3.1 State Requirements

Section 373.470, F.S., requires that the PIR identify the increase in water supplies resulting from the project components and that the additional water be allocated or reserved under Chapter 373, F.S. The Acceler8 is providing this same information for the public's use.

The EAA Reservoir A-1 project is intended to affect Lake Okeechobee, the St. Lucie and Caloosahatchee Estuaries, and WCAs 3 and Everglades National Park. In terms of the quantity of water for the protection of fish and wildlife in these areas, the project's effects have been evaluated by comparing volume probability curves based on water budget data produced by a regional scale model (the South Florida Water Management Model vs. 5.4). To identify project effects, the regional water management system including the operations of the selected alternative plan have been simulated with the regional model, and the modeled outputs compared to those produced for the base condition representative of the initiation of project operations (Existing Condition).

Similar to the process for identifying water for the protection of fish and wildlife, to evaluate effects of the project on water for other water-related needs, the selected alternative plan is added to other components of the regional water management system and modeled with the regional hydrologic simulation model, and the modeled outputs compared to those produced for the existing condition representing conditions as of 2005 (Existing Conditions). The project's effects have been evaluated by applying water supply performance measures used during plan formulation for the PIR produced by a regional scale model.

3.2 Model Simulation Period

The model used to determine project effects simulates the period from January 1, 1965 through December 31, 2000. Therefore, there are 36 years of data but only 35 water years (November 1, 1965 through December 31, 2000) considered in the analysis of water to be reserved for the natural system.

3.3 Volume Probability Curves

For purposes of identifying water for the natural system, volume probability curves are produced depicting the range of the quantities of water delivered to selected natural areas under all climatic conditions through the period of record used to perform project evaluations. The volume probability curve indicates the probability (percentage of time equaled or exceeded) that a certain quantity of water is delivered to natural areas for fish and wildlife protection as a function of historical rainfall distribution. To identify incremental project effects, volume probability curves for the with-project condition are compared to volume probability curves for the existing condition in 2005.

Volumes of water to be potentially made available by the EAA Reservoir A-1 project were synthesized from SFWMM simulations, and are based on a 36-year (35-water-year) simulated period of record. The total volume of water made available by the project was synthesized for each water year as the difference between volumes observed in the "without-project" simulation and the "with-project" simulation. For each water year, the observed differences (i.e., with-project-volume minus without-project-volume) in volumes delivered into and out of a given subbasin were noted, and charted as: time series of total annual volumes made available; and total annual volume exceedance curves.

In an effort to present the potential utility and benefit of the EAA Reservoir A-1 project, while recognizing that potential near-term constraints on its operations exist, the volumes to be potentially made available by the EAA Reservoir A-1 project are presented as a volume envelope. The upper and lower quantities of the volume envelope illustrate total volumes of water that could be made available as a result of this project's implementation.

3.4 Water Made Available by the Project for Natural System

3.4.1 System-wide Effects

For those projects expected to result in system-wide effects on the natural system and other water related needs in south Florida, a regional-scale hydrologic simulation model is utilized to evaluate those effects. Due to its central location, storage volume, and influence on the regional water budget, the EAA Reservoir A-1 project is expected to have system-wide effects. To identify these effects and quantify the water made available by the project, a model simulation representing Existing Conditions in 2005 (the timeframe for the EAA Storage Reservoir's Project Implementation Report) is compared to a simulation of the same existing conditions plus the EAA Reservoir A-1 project's selected plan features and operations (Table 3.4-1).

To evaluate system-wide effects on the natural system, the SFWMM is used to identify the quantity, timing, and distribution water made available by the project in the Water Conservation Areas (WCAs) and Everglades National Park.

Water made available by the EAA Reservoir A-1 project includes both water for the natural system and water for other water related needs. The water evaluation results indicate that the EAA Reservoir A-1 project makes additional water available for the natural system in WCA-3A, WCA-3B, and Everglades National Park.

Table 3.4-1 Summary of Model Simulations for EAA Storage Reservoir

	Existing Condition (2005) (Ex PIR)	Existing Condition w/A-1 Reservoir (2005) EAA-No RDO	Existing Condition w/A-1 Reservoir EAA-RDO	NSM462
Selected Plan – EAA Storage Reservoir	No	Yes	Yes	n/a
Regional System Operations	2005	2005	2005	n/a
System Demands and Land Use	2005	2005	2005	n/a
Everglades Construction Project	STAs 1W, 2, 5, 6	STAs 1W, 2, 3/4 5, 6	STAs 1W, 2, 3/4, 5, 6	n/a
Everglades Rain Driven Operations	No	No	Yes	n/a
Non-CERP Projects*	2005	2005	2005	n/a
Model simulation used as basis	2005B	2005B	2005B	NSM v 4.6.2.

The goals of this project include increasing the quantity of water and improving the timing and distribution of water delivered to the Water Conservation Areas and Everglades National Park and reducing damaging high water levels in Lake Okeechobee and the St. Lucie and Caloosahatchee estuaries. This is accomplished by storing runoff and Lake Okeechobee discharges, and providing an alternate source of water for agricultural water users in the EAA in lieu of withdrawals from Lake Okeechobee. One of the fundamental principles of the CERP is to capture and store water that is lost to tide or discharged to or stored in natural areas when those areas do not require additional water, and use the stored water to improve regional water availability.
The EAA Reservoir A-1 project is intended to capture water that would be lost to tide via the C-44 and C-43 Canals, and to provide an alternate storage facility in lieu of keeping water in Lake Okeechobee when lake water levels should be falling or when high water levels require regulatory releases. Water stored in the EAA Reservoir A-1 is to be used for environmental deliveries to the Everglades (via delivery to Water Conservation Area 3) and for water supply deliveries in the EAA via the North New River in lieu of the current withdrawal of water from Lake Okeechobee via the North New River. Creation of this supplemental source of water is expected to result in improved hydroperiods and hydropatterns necessary to support fish and wildlife habitat in the Everglades, increase the quantity of water available to be delivered for the natural system within the Water Conservation Areas and Everglades National Park, and increase the quantity of water available to meet agricultural water supply demands in the EAA.

Project effects are quantified by comparing a model simulation representing Existing Conditions in 2005 (the timeframe for the EAA Reservoir A-1 project Implementation Report) to a simulation of the same existing conditions plus the EAA Reservoir A-1 project's selected plan features and operations. Because it is recognized that constraints on operations currently exist, the volumes to be potentially made available by the EAA EAA Reservoir A-1 project are presented as a volume envelope. The ranges of the volume envelope illustrate total volumes of water that could be made available as a result of this project's implementation. The model runs labels are EAA_ExCond for the Existing Conditions and EAA_No RDO and EAA-RDO for the envelope ranges of the Existing Conditions PIR plus the project:

- EAA_No RDO – A conservative with project simulation (EAA Reservoir A-1 operated to act as a surge tank for Lake Okeechobee releases) performed for comparison to Existing Conditions baseline; represents conditions expected upon initial operation of the project based on projects, features, and regional water management policies/practices as they exist today (e.g., WCAs operated using regulation schedules)

- EAA_RDO – Potentially optimized with-project simulation performed for comparison to caselines to evaluate project effect; represents the amount of water that the project can provide to the natural system once existing constraints on operations are reduced/removed and regional water management practices adapted to more "need-based" natural system deliveries (e.g., WCAs operated using rainfall/depth-based targets).

It is intended that this project will be operated to yield no adverse impacts to downstream natural areas, delivering water to downstream natural areas in a manner that is consistent with restoring and/or sustaining hydrologic conditions necessary to protect fish and wildlife. Until such time that those deliveries can be made in the manner described, it is recognized that the total volumes of water made available by the EAA Reservoir A-1 project for introduction to the Everglades Protection Area are likely to remain near the lower-end of the described volume envelope. Once existing constraints on operations are reduced and/or removed such that additional water could be delivered in the manner described (i.e., in a manner consistent with restoration goals), total volumes of water made available by the EAA Reservoir project for introduction to the Everglades Protection Area are anticipated to increase to be near but not limited to the higher-end of the described volume envelope.

Consistent with the project purpose and objectives to improve hydroperiods and hydropatterns in the Everglades, modeling to evaluate effects on the quantity of water made available by the project for the natural system in the EAA_RDO scenario included a partial implementation of rain-driven operations in the Everglades. For the most part, modeling results indicate that the EAA Reservoir A-1 project is affecting flows to WCA 3A, 3B and Everglades National Park.

Loxahatchee National Wildlife Refuge (WCA 1) - The model results indicate that the project does not substantially change inflows or outflows to WCA1.

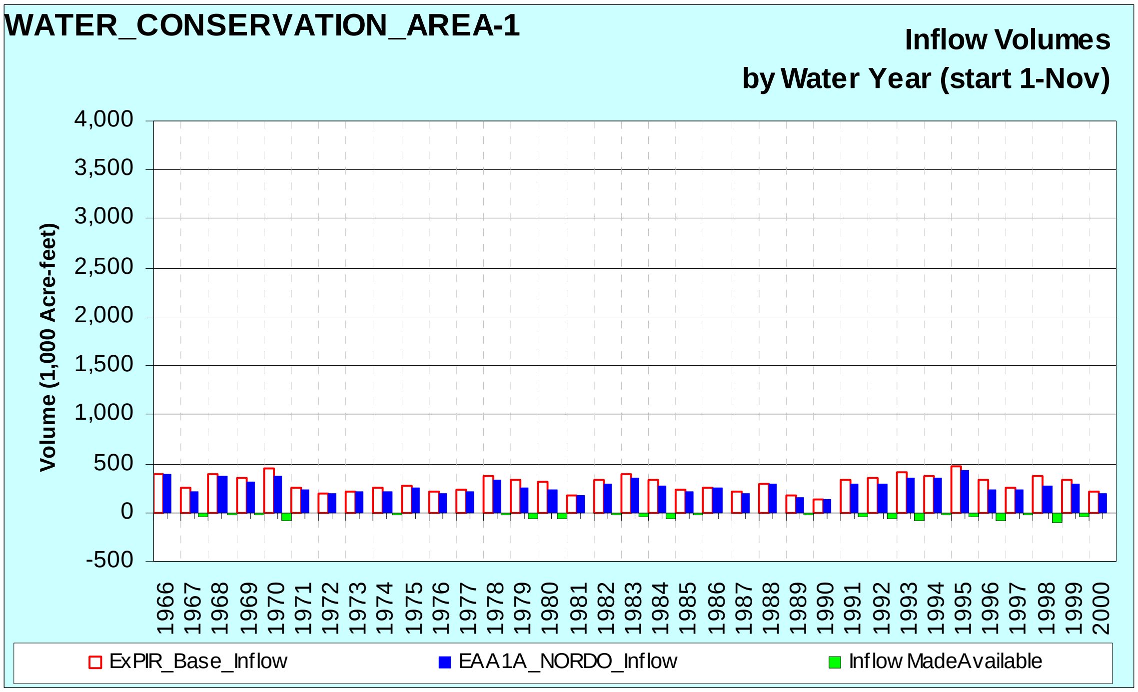
Water Conservation Area 2A - The EAA Reservoir A-1 project appears to slightly decrease inflows and outflows to WCA2A.

Water Conservation Area 2B - The results indicate that the project does not significantly change the inflow or outflow volumes in WCA2B.

Water Conservation Area 3A - In most years, the EAA Reservoir A-1 project appears to create additional inflows in WCA 3A.

Water Conservation Area 3B - Modeling results indicate that in most years the EAA Reservoir A-1 project will create a significant quantity of additional water through inflows in WCA-3B.

Everglades National Park - The model results indicate that the EAA Reservoir A-1 project provides additional water via inflows to ENP in most years.



WATER_CONSERVATION_AREA-1
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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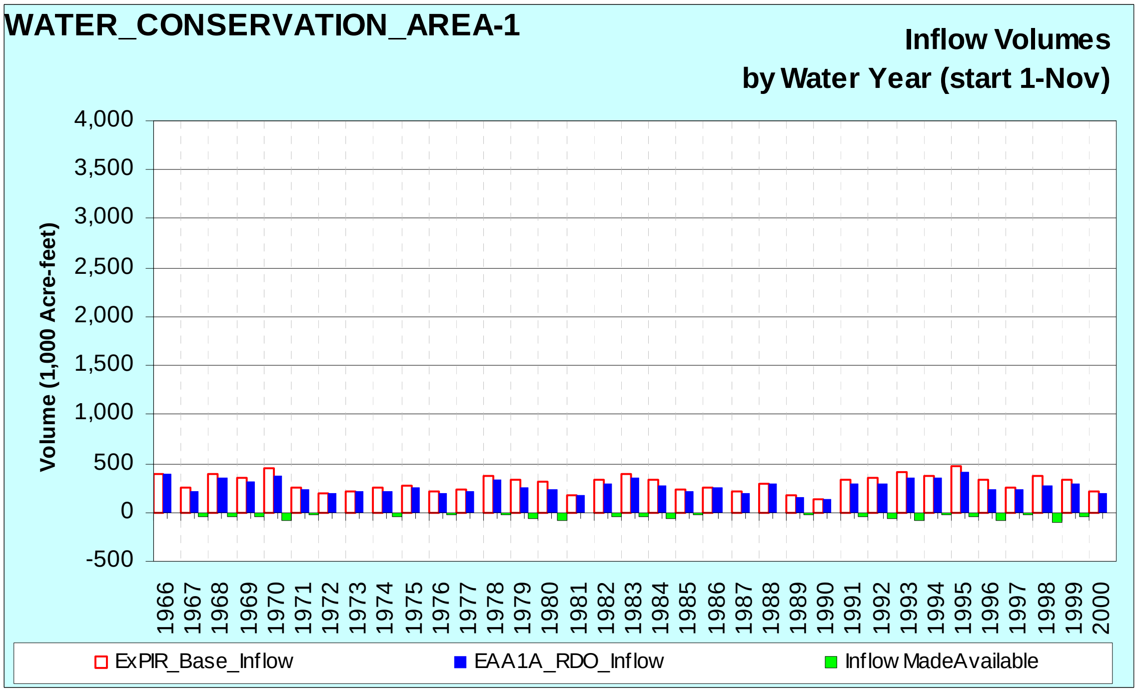
EAA1A_NORDO_Inflow
Inflow MadeAvailable



WATER_CONSERVATION_AREA-1
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,000
2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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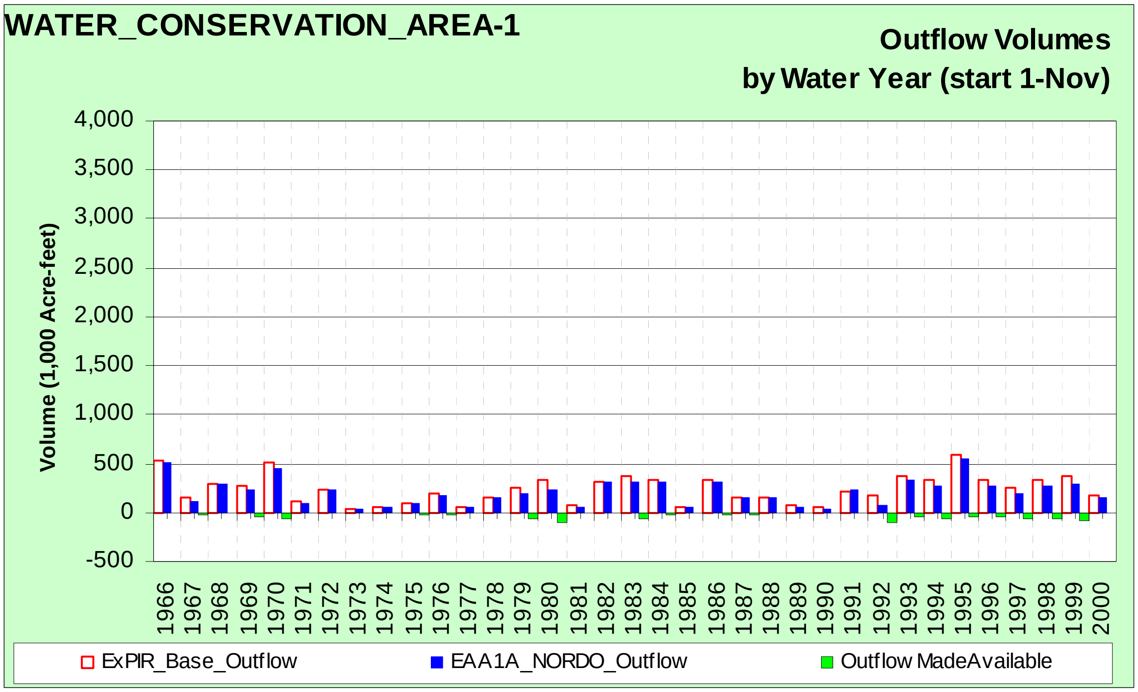
EAA1A_RDO_Inflow
Inflow MadeAvailable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Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,000
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1,500
1,000
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1966
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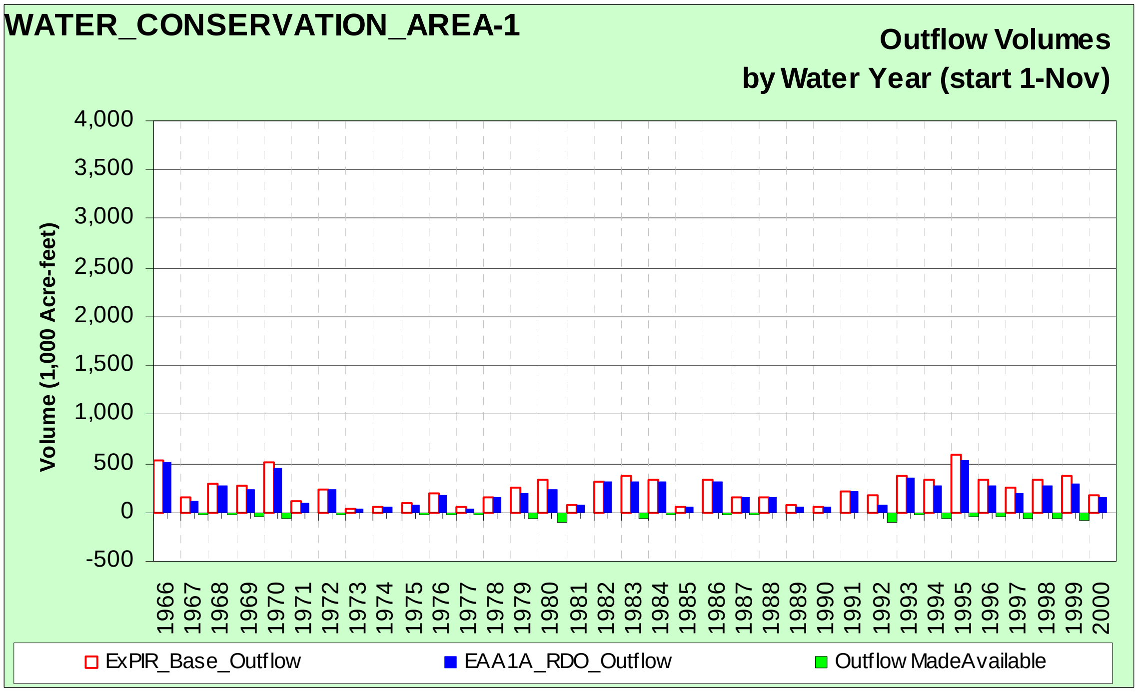
Outflow MadeAvailable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Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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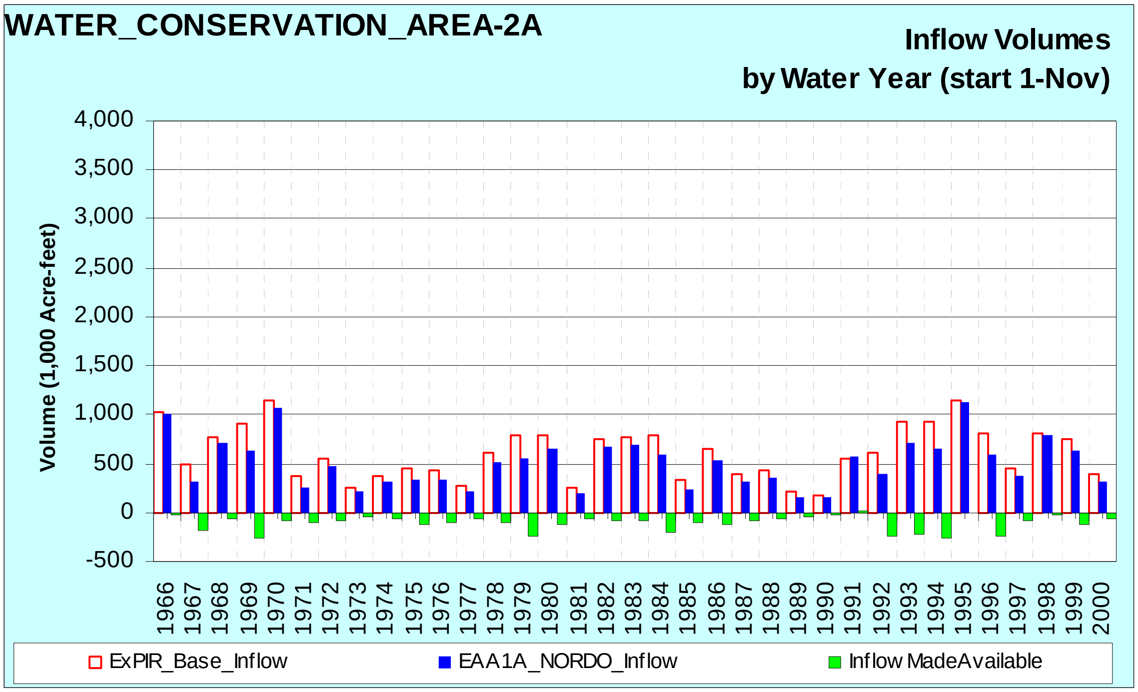
Outflow MadeAvailable



WATER_CONSERVATION_AREA-2A
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,000
2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
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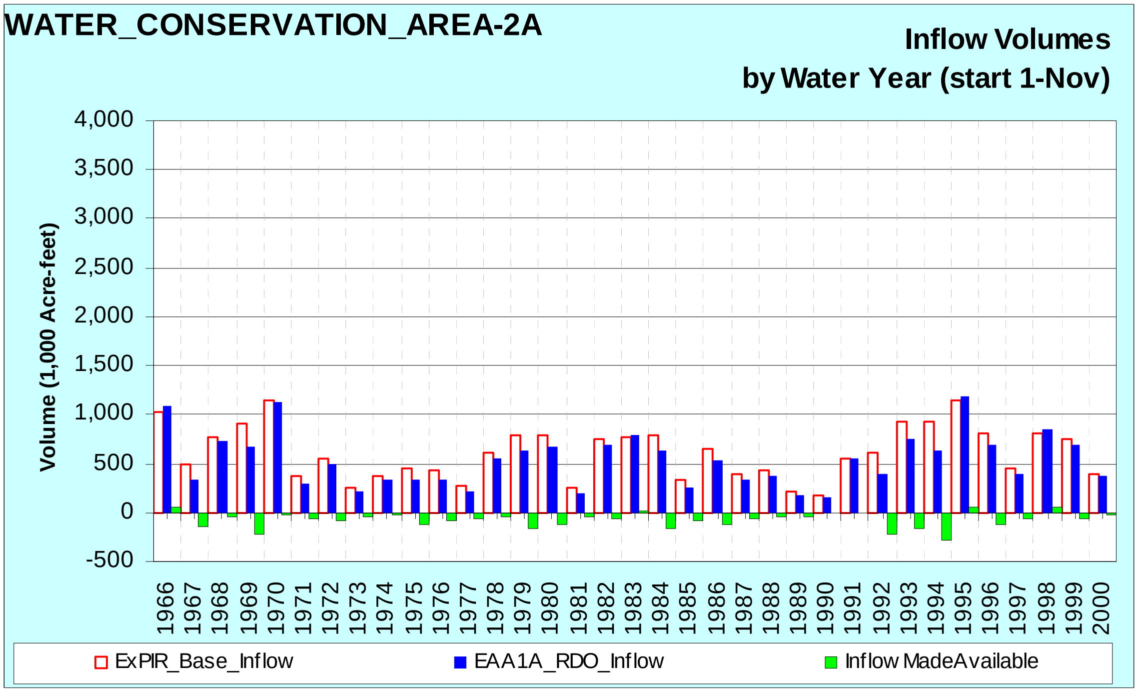
EAA1A_NORDO_Inflow
Inflow MadeAvailable



WATER_CONSERVATION_AREA-2A
Inflow Volumes
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Volume (1,000 Acre-feet)
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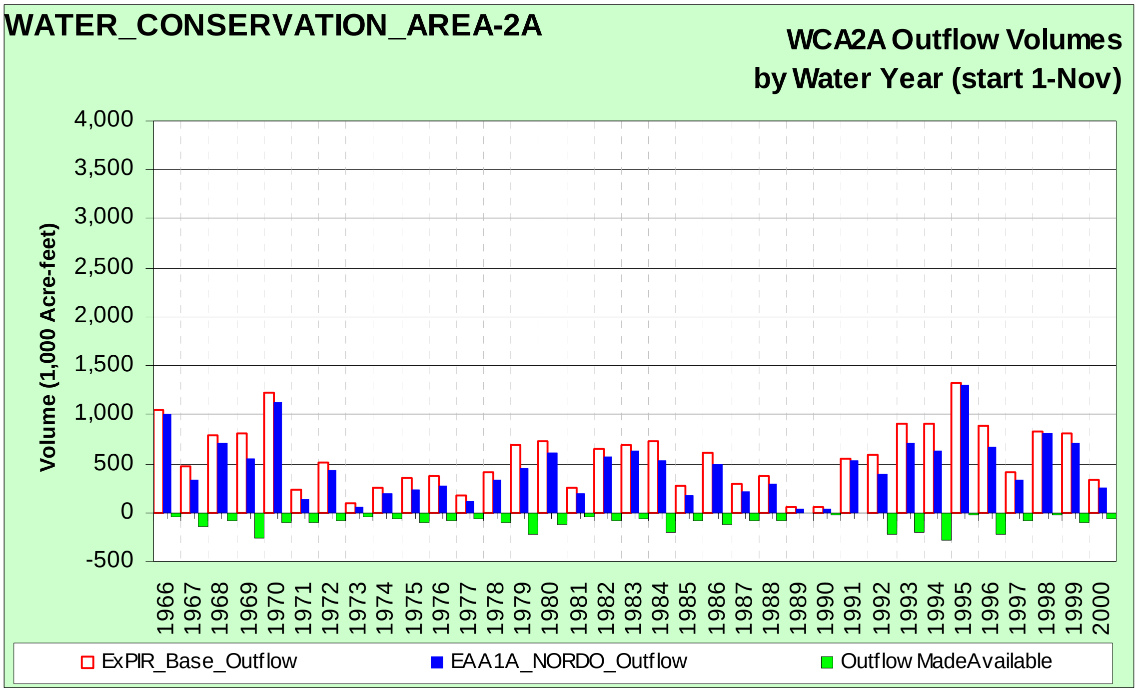
2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
ExPIR_Base_Inflow
EAA1A_RDO_Inflow
Inflow MadeAvailable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WCA2A Outflow Volumes
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Volume (1,000 Acre-feet)
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2,000
1,500
1,000
500
0
-500
1966
1967
1968
1969
1970
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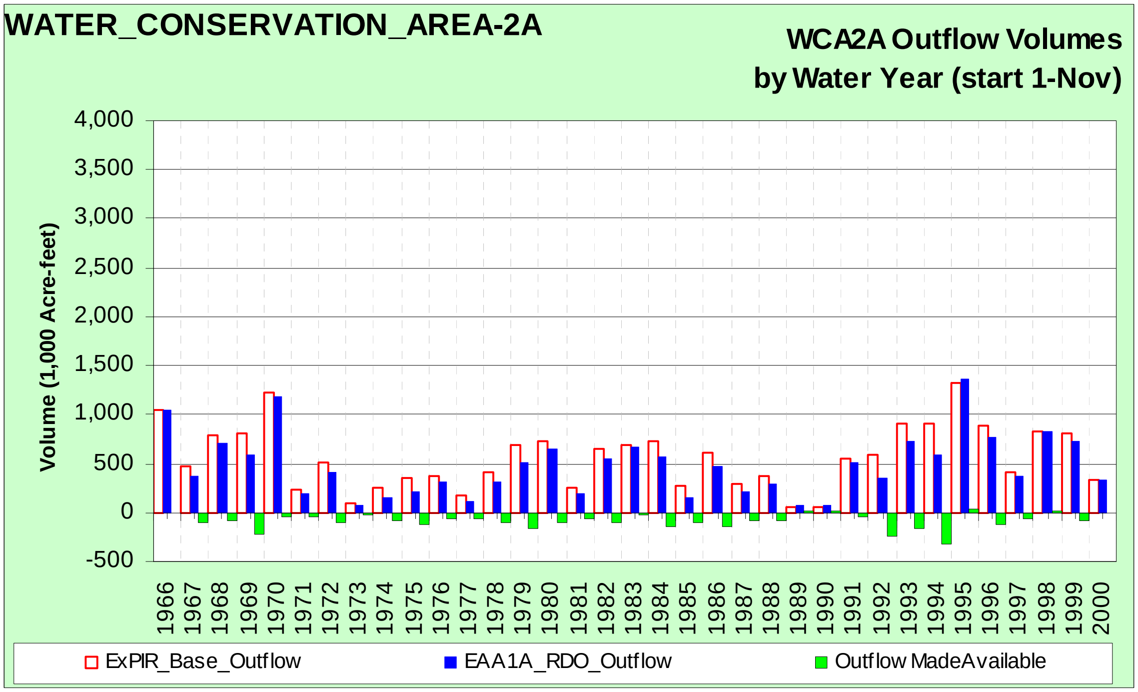
ExPIR_Base_Outflow
EAA1A_NORDO_Outflow
Outflow MadeAvailable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WCA2A Outflow Volumes
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Volume (1,000 Acre-feet)
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-500
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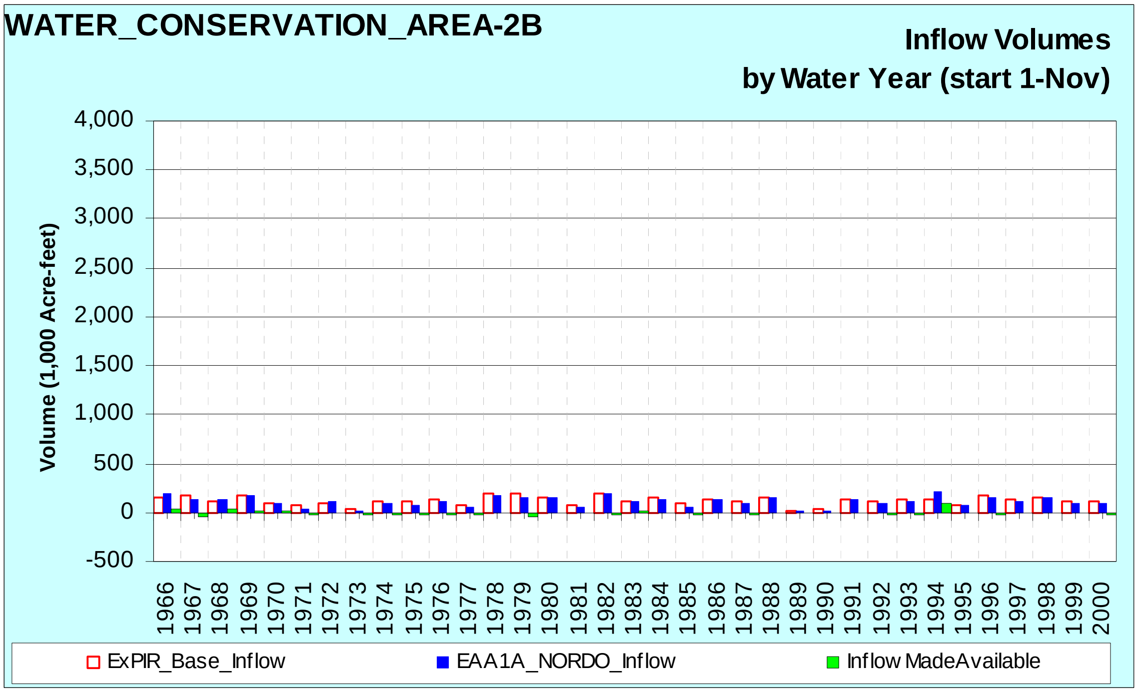
Outflow MadeAvailable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Volume (1,000 Acre-feet)
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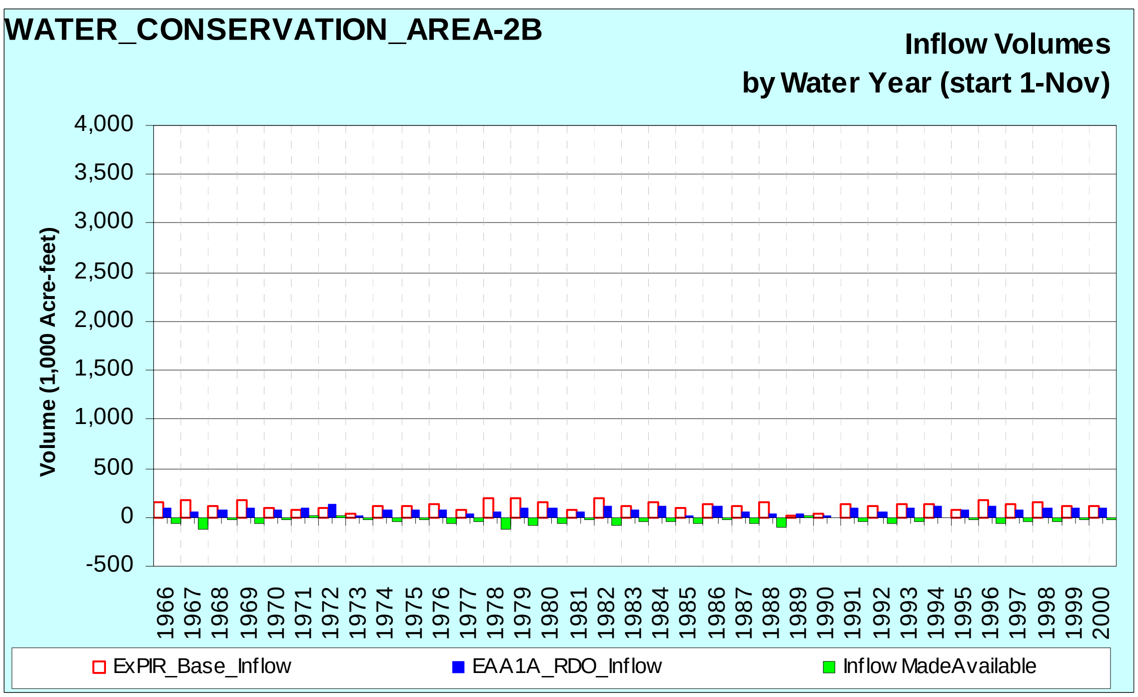
2,500
2,000
1,500
1,000
500
0
-500
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
ExPIR_Base_Inflow
EAA1A_NORDO_Inflow
Inflow MadeAvailable


WATER_CONSERVATION_AREA-2B
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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3,500
3,000
2,500
2,000
1,500
1,000
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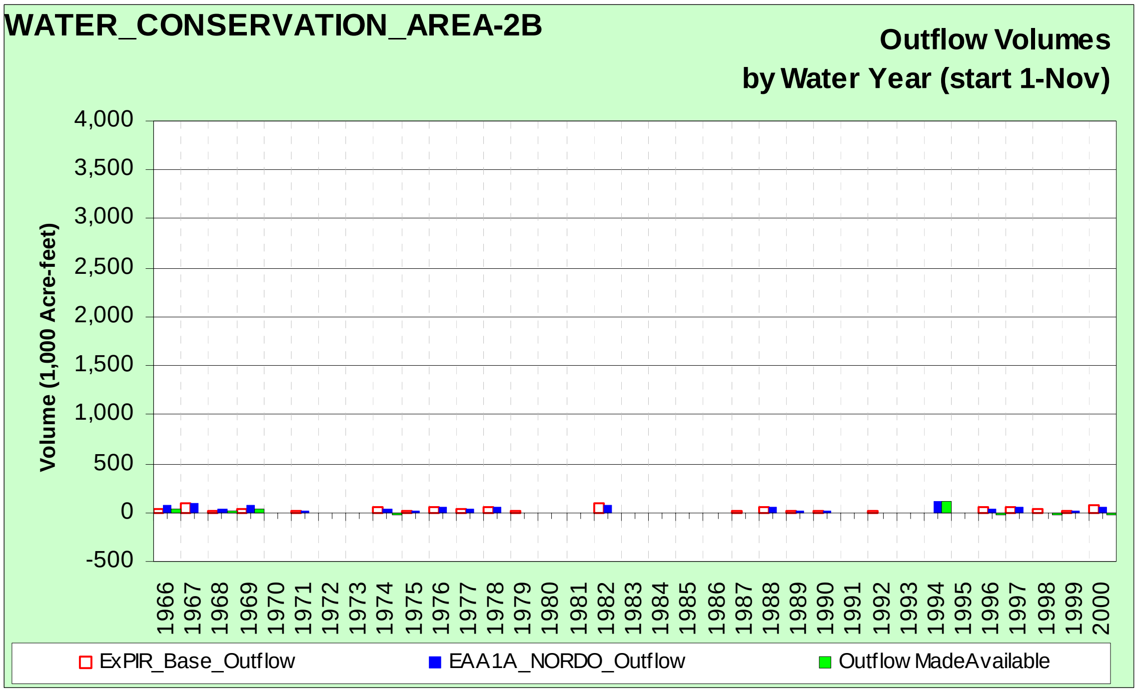
1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
ExPIR_Base_Inflow
EAA1A_RDO_Inflow
Inflow MadeAvailable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Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
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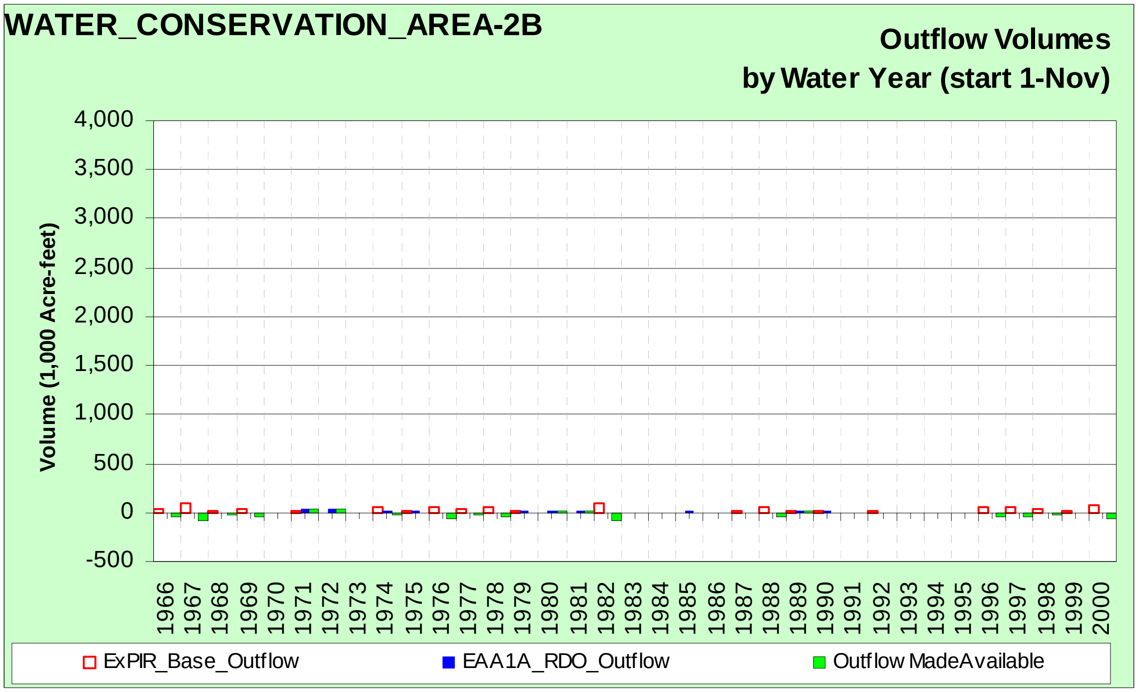
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by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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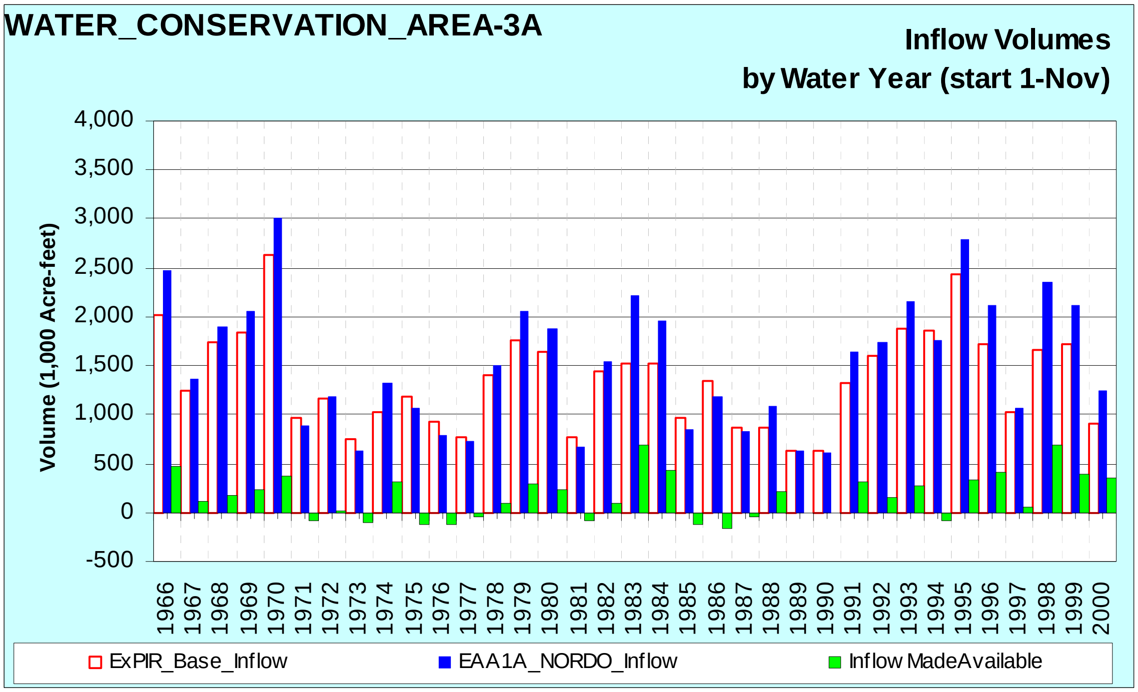
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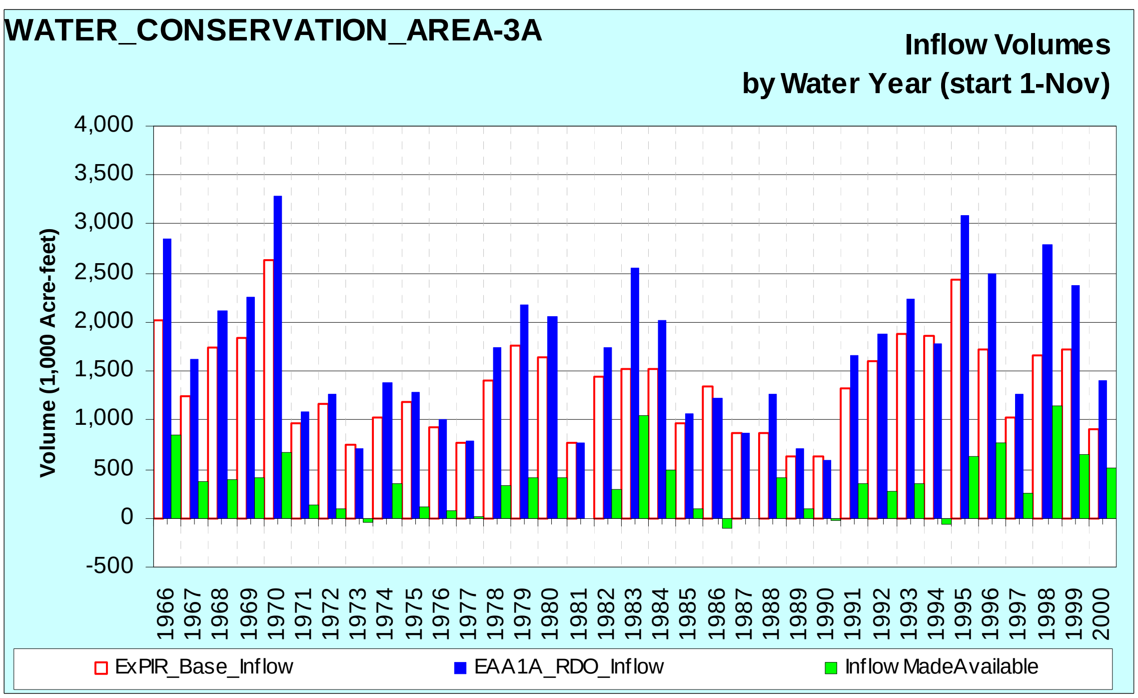
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Volume (1,000 Acre-feet)
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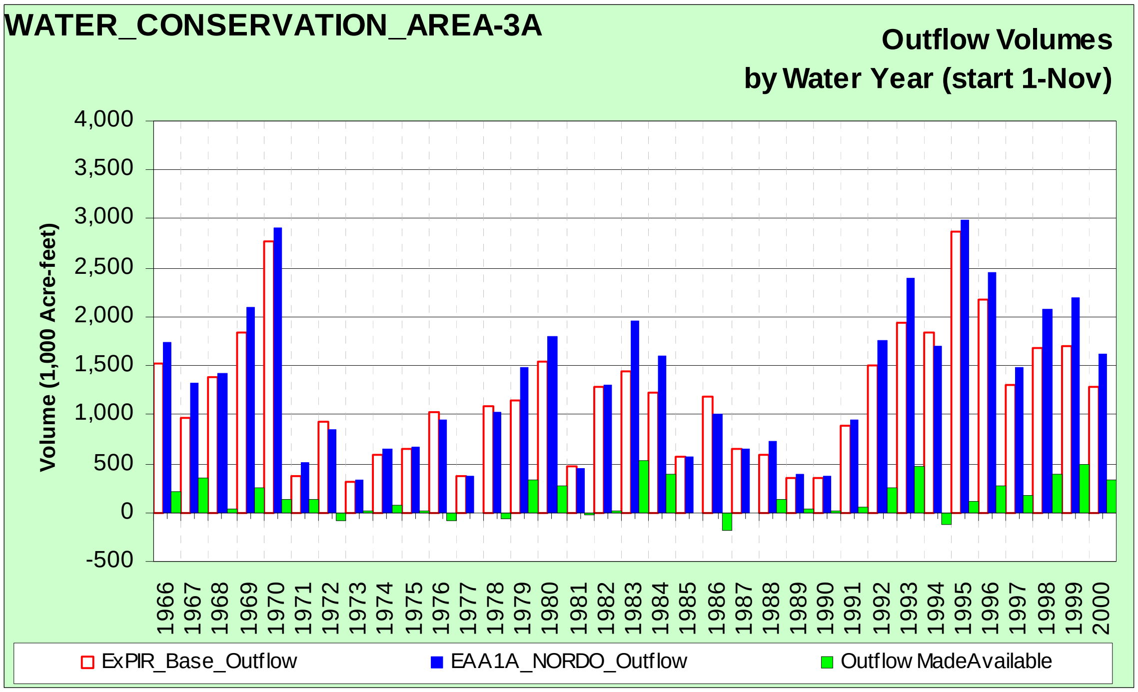
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Volume (1,000 Acre-feet)
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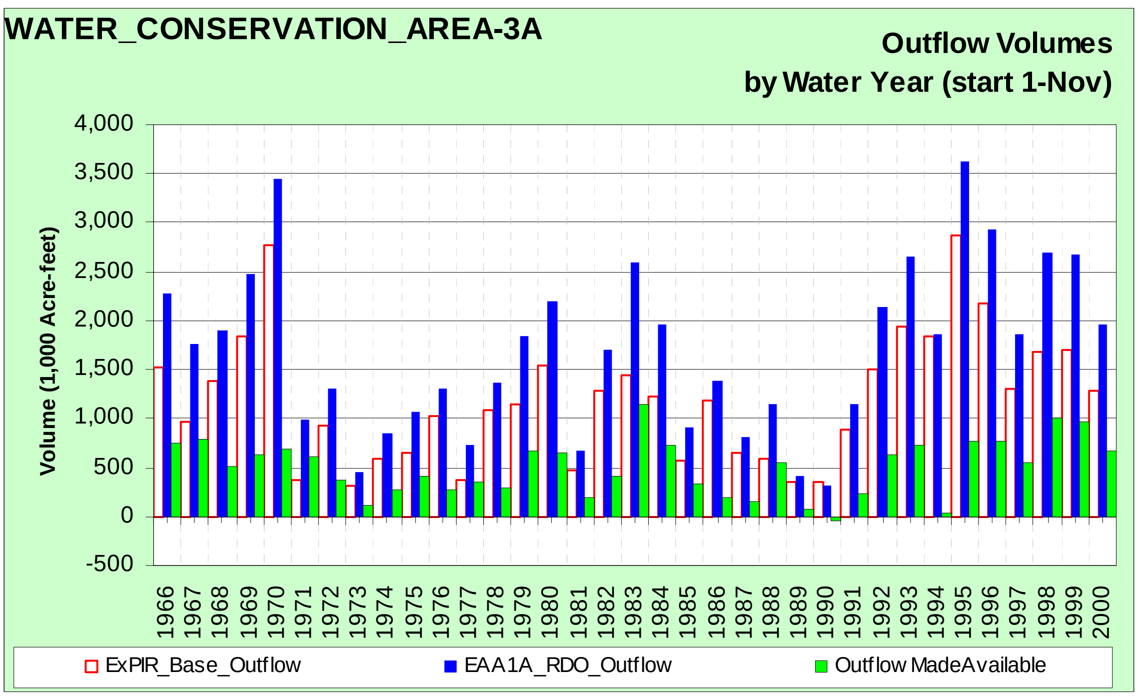
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Volume (1,000 Acre-feet)
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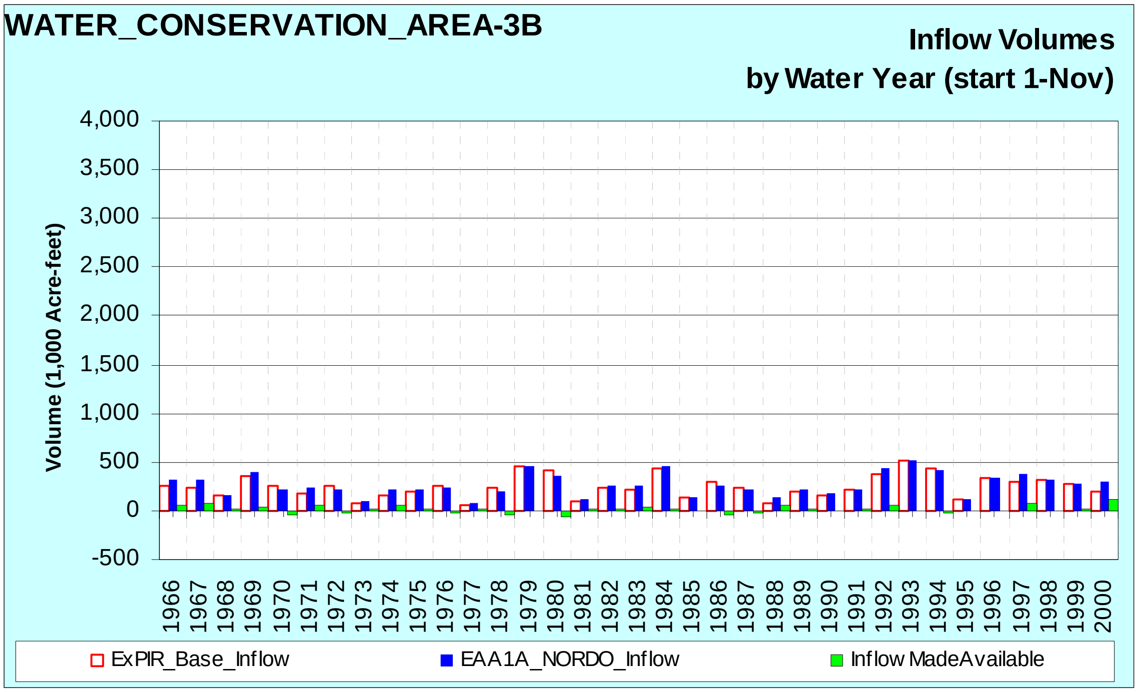
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Volume (1,000 Acre-feet)
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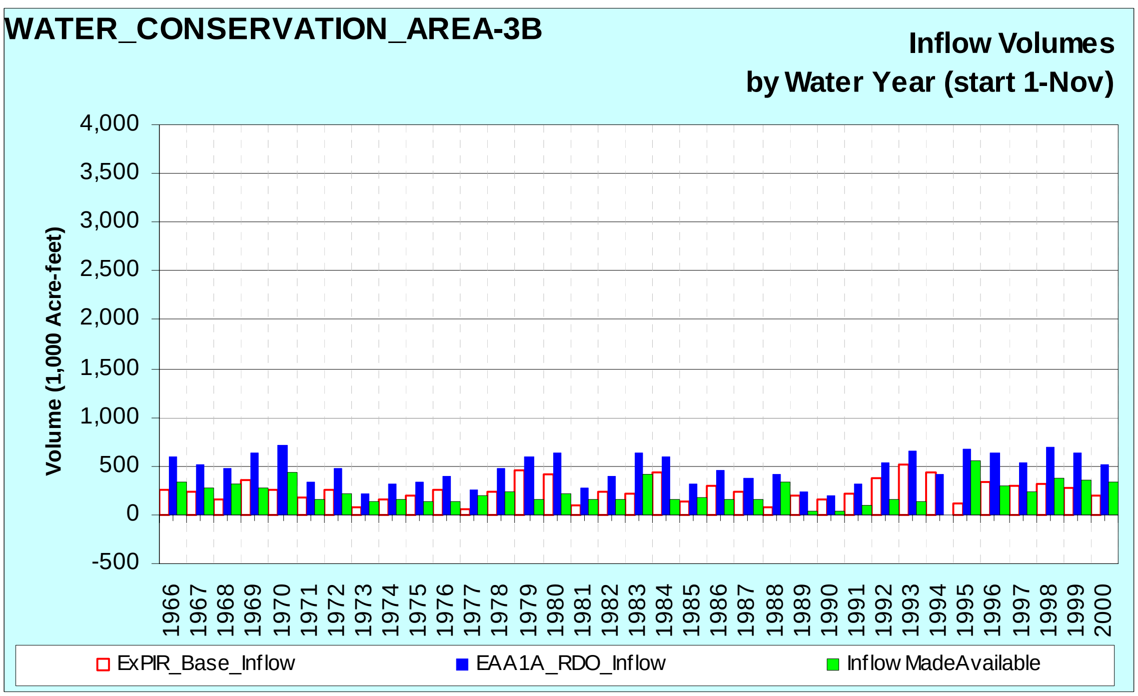
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Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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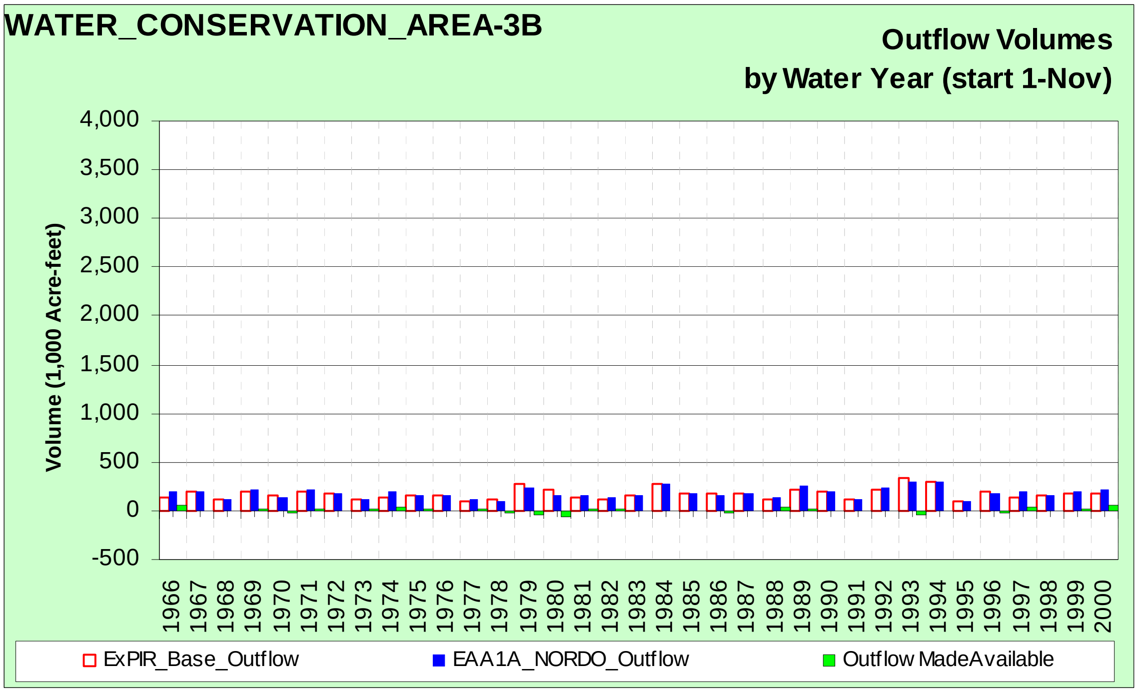
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Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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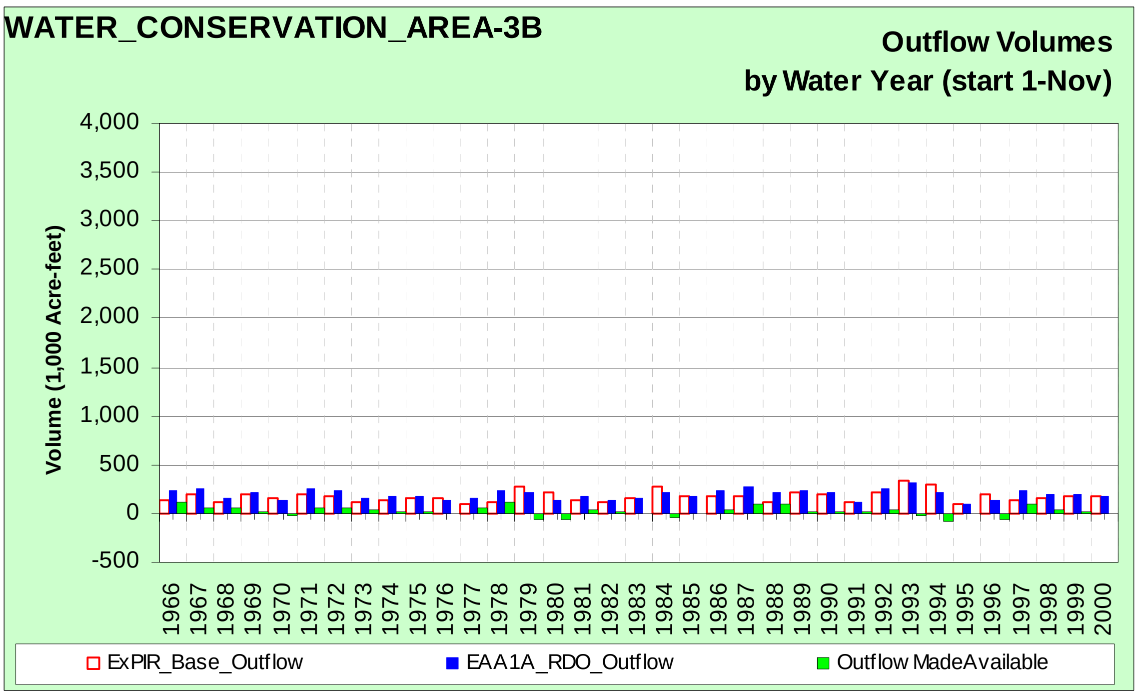
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Outflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
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EAA1A_RDO_Outflow
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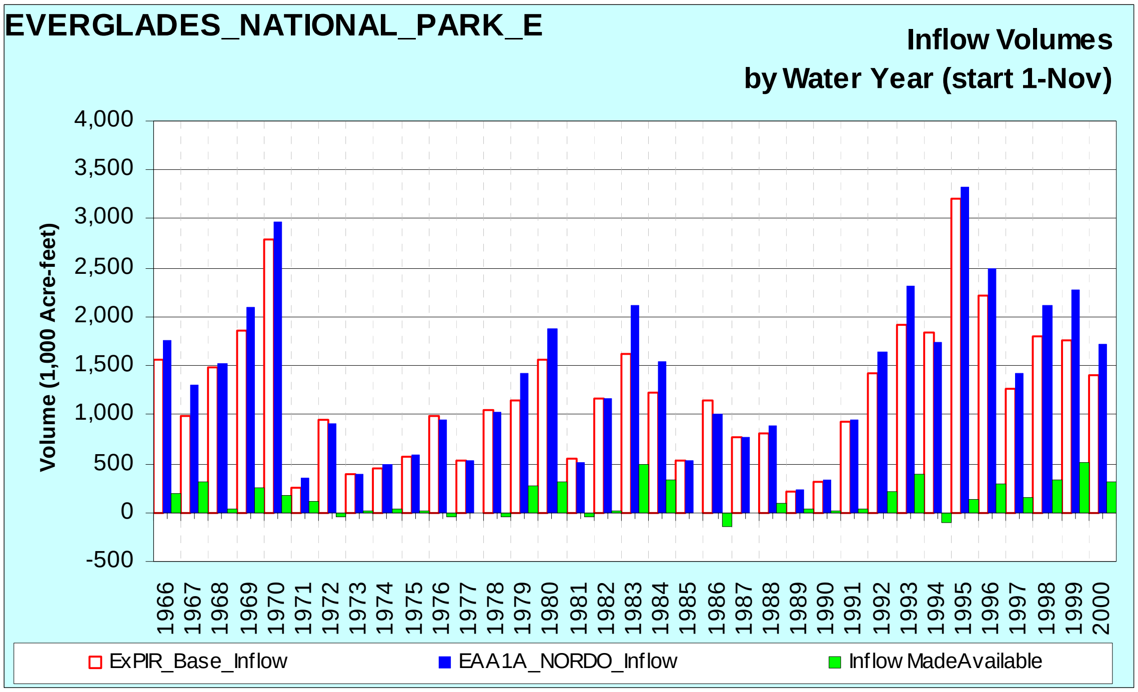
EVERGLADES_NATIONAL_PARK_E
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
3,500
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2,500
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EAA1A_NORDO_Inflow
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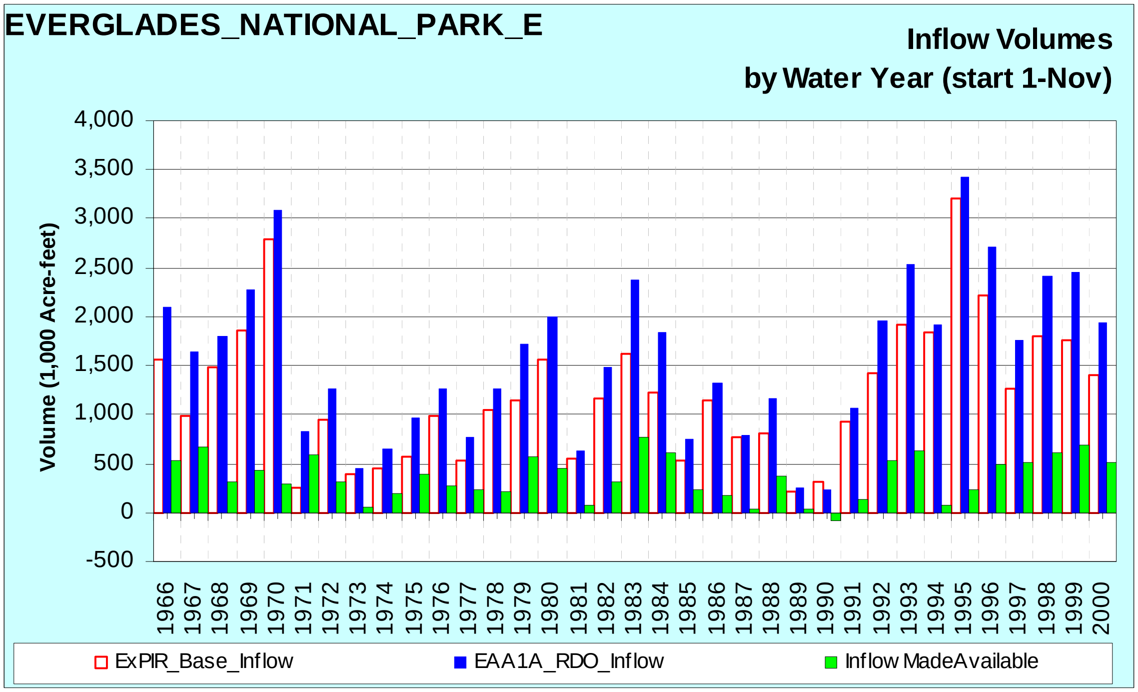
EVERGLADES_NATIONAL_PARK_E
Inflow Volumes
by Water Year (start 1-Nov)
Volume (1,000 Acre-feet)
4,000
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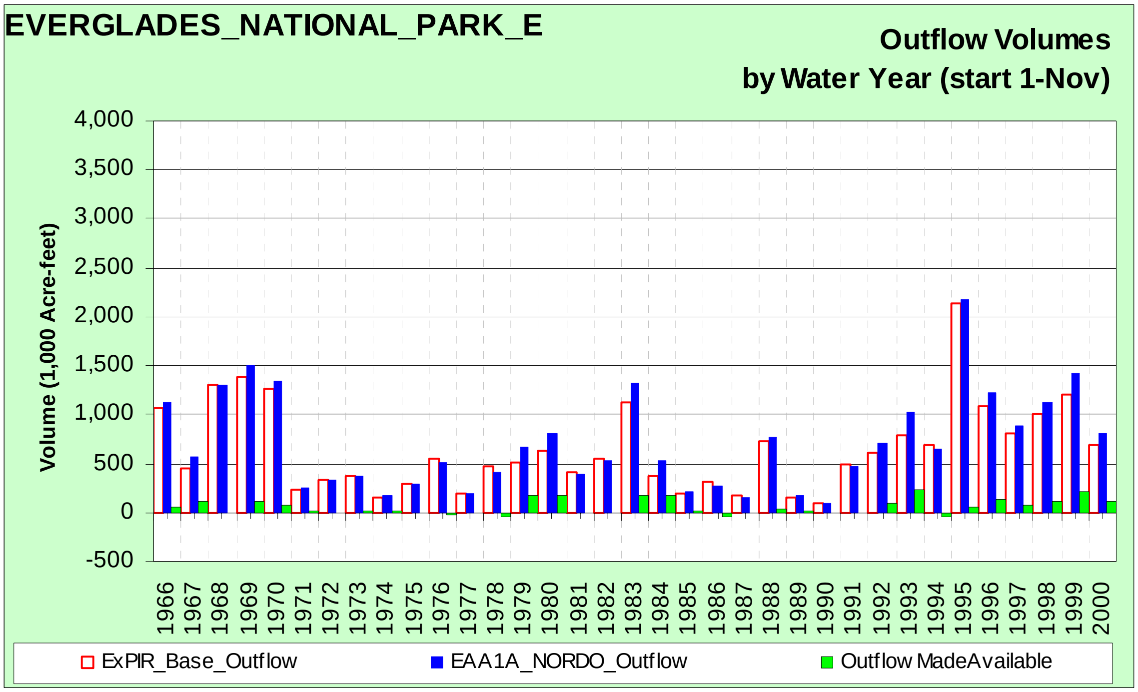
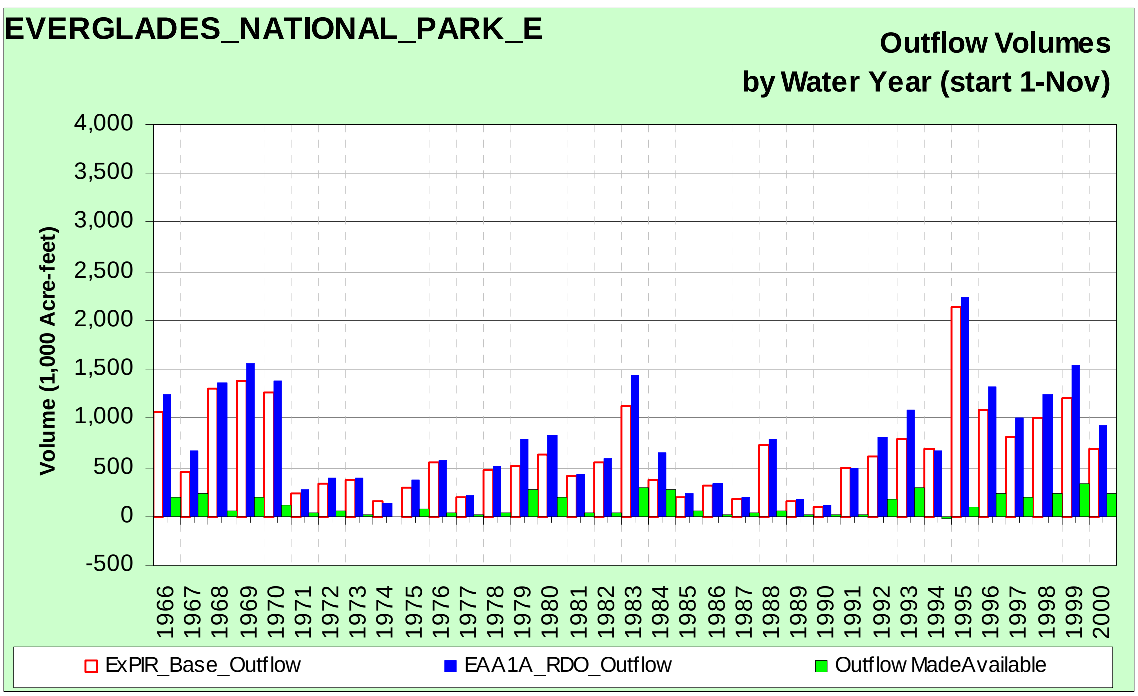




3.4.2 Project Level Effects

Although the EAA Reservoir A-1 project includes project-level features within impoundment cells and seepage canals that may provide fish and wildlife habitat, these are incidental effects that are the result of environmentally responsible design features. The primary purpose of the seepage management features is to protect adjacent lands from potentially damaging high water levels. The improved fish and wildlife habitat in the seepage management area is expected to be somewhat ephemeral, and is dependent on operations of the impoundment cells to achieve the primary objectives of water storage and delivery of stored water for environmental and agricultural water supply. The deepwater refugia provided by the excavated areas within the impoundment will also provide fish and wildlife habitat, but the project will not be operated and managed to optimize these incidental environmental effects within the impoundment cells. Since these project-level features were not specifically formulated to increase the quantity of water for the natural system, a project-level evaluation to identify project-level water was not performed.

3.5 Water Made Available by the Project for Other Water Related Needs of the Region

The EAA Reservoir A-1 project stores discharges from Lake Okeechobee and runoff from the EAA that would otherwise be discharged to tide or delivered to the Everglades when the Everglades do not need additional water. Water is released from the EAA Reservoir A-1 to meet natural system water supply needs in the Everglades and agricultural supplemental irrigation needs in the Everglades Agricultural Area (EAA). This reduces the demand on Lake Okeechobee to function as a source of supply to meet those needs, and prevents low lake levels that contribute to water supply restrictions in the Lake Okeechobee Service Area (LOSA) and Lower East Coast Service Areas; therefore, implementation of the EAA Reservoir A-1 project increases the net amount of water available in the C&SF Project.

To determine the quantity of water made available for other water-related needs, metrics used include whether public water supply demands and supplemental irrigation demands for agriculture can be met and whether resources can be protected (e.g., salt water intrusion into fresh water aquifers). These metrics are directly linked to the goals and purposes of CERP.

Also worth noting is the reduction in demand for supplemental irrigation associated with the conversion of agricultural lands within the Everglades Agricultural Area due to the footprint of the EAA Reservoir A-1 project. The overall demand for supplemental irrigation in the Everglades Agricultural Area decreases from an annual average of 348,000 ac. ft. in the existing (ExPIR) condition to 318,000 ac. ft. as a result of project implementation (No RDO & RDO).

The volume of water stored in the impoundment creates a net increase in the volume of water capable of being delivered to the EAA to meet agricultural water supply needs. This represents the total amount of water provided directly by the project to meet the other water-related needs of the region. Table 3.5-1 summarizes these amounts as calculated from SFWMM simulations of Existing PIR condition with EAA Reservoir A-1 project under both operating conditions (No RDO and RDO). Annually, on average approximately 98,000 to 102,000 ac-ft of water stored by the EAA Reservoir A-1 is available in addition to the existing sources of water for the EAA (EAA runoff and Lake Okeechobee).

Table 3.5-1Total and Average Annual Discharges from EAA Storage Reservoir for Other Water-Related Needs (Thousand acre-feet)

Basin	2005 Existing Condition with EAA Reservoir A-1 (Thousand acre-feet) (No RDO)		2005 Existing Condition With EAA Reservoir A-1 (Thousand acre-feet) (RDO)	
	Average Annual	Total for 36 yr simulation	Average Annual	Total for 36 yr simulation
North New River Basin	102	3,664	98	3,542
Miami Basin	0	0	0	0
Discharges to NNRC & Miami Basins	102	3,664	98	3.542

For the Lake Okeechobee Service Area, the mean annual supplemental irrigation demands met and not met are similar and in some basins more irrigation demands are met by Lake Okeechobee when comparing the Existing PIR Conditions to the Existing PIR condition with EAA Storage Reservoir (see Table 3.5-2) under either operating condition. When Lake Okeechobee stages fall to the Supply Side Management zone (SSM) on the Lake's regulation schedule, a portion of the water supplies to the Lake Okeechobee Service Area (LOSA) and Lower East Coast Service Areas (LECSA) is restricted from their use.

Table 3.5-2 Mean Annual Volume of Supplemental Irrigation Deliveries Met and Not Met (Thousand Acre Feet) by Lake Okeechobee and EAA Storage Reservoir

Basin	2005 Existing Condition (ExPIR) (Thousand acre-feet)		2005 Existing Condition with EAA Reservoir A-1 (No RDO/RDO) (Thousand acre-fee)	
	Deliveries Met	Deliveries Not Met	Deliveries Met	Deliveries Not Met
EAA	323	25	318/310	13/30
S-4, S-236, L-8, Lower Istokpoga, N & NE Lake Shore basins Plus 298 districts	85	5	86/82	4/8
C-43/Caloosahatchee Basin	111	6	112/107	5/10
C-44/St Lucie Basin	26	2	27/25	1/3
Seminole Tribe – Big Cypress Reservation	24	5	28/28	1/1
Seminole Tribe – Brighton Reservation	27	1	28/26	1/2

The Lower East Coast Service Areas performs similar to LOSA with either the same or improvements to the ability of the C&SF Project to meet water demands. Both the number of times and duration of water supply restrictions considered significant[1] in LOSA and LECSA decrease when the EAA Reservoir A-1 project operates as simulated in the SFWMM (See Table 3.5-3), thereby ensuring similar or an increase in the amount supplemental irrigation demands and public water supply demands can be met. As the number and duration of restrictions decrease, the total volume of water available for use in the Lower East Coast Service Area to meet urban and agricultural demands also increases.

Table 3.5-3 Number of Years with a Restriction Event and Total Number of Months of Restrictions in 36 year Simulation

	2005 Existing Condition (ExPIR)		**2005 Existing Condition with EAA Reservoir A-1 (No RDO/RDO)**	
Service Area	Number of Years	Total Number of Months	Number of Years	Total Number of Months
LOSA	9	25	6/12	16/33
LECSA 1	6	39	6/7	41/35
LECSA 2	24	128	24/24	129/132
LECSA 3	5	36	5/6	37/42
North Palm Beach SA	5	34	5/6	36/43

Percentage of demands not met provides another way to look at all basins and service area performance using the same metric. The percentage of supplemental irrigation and public water supply demands not met tied to Lake Okeechobee or groundwater stages in the Biscayne aquifer remain essentially the same with project implementation (see Table 3.5-4).

[1] Three criteria are used to determine if the water restrictions are significant in LOSA. First, for a month to be counted there must be supply-side restrictions for seven or more days; second, the reductions in deliveries must be 10% or more; and third, the total reduction in deliveries during the month must exceed 18,000 acre feet. Any water year with one or more months meeting these criteria is counted as a year with significant supply-side restrictions. For LECSA, some of these shortages result from local conditions beyond the reach of the regional water system. Water restrictions less than two months in duration triggered by local groundwater conditions will not be considered a regionally significant water shortage.

Table 3.5-4 Percentage of Supplemental Agricultural and Public Water Supply Deliveries Not Met[2]

	2005 Existing Condition (ExPIR)	**2005 Existing Condition with EAA Reservoir A-1 (No RDO/RDO)**
Service Area	Percent of Deliveries Not Met (percent)	Percent of Deliveries Not Met (percent)
EAA	7	24/9
Other LOSA[3]	6	5 /9
LECSA 1	1.4	1.4/1.4
LECSA 2	4.6	4.6 //4.8
LECSA 3	1.4	1.2/1.4
North Palm Beach SA	1.2	01.2/1.4

Another use of water supplied by the C&SF Project is to maintain stages in its primary coastal canals to prevent salt-water intrusion of the Biscayne aquifer. Operating criteria and reference stages for control structures located nearest the Atlantic Ocean were established as part of the minimum flow and level necessary to protect the Biscayne aquifer from serious harm. Inability to meet these stages for 180 days exceeds the Minimum Flows and Levels (MFL) criteria. The 2005 Existing Conditions model run fails to meet the criteria once at one location in the 36 year simulation, the C-4 Canal at the S-25B structure. Modeling of the 2005 Existing Conditions with EAA Storage Reservoir results in meeting the criteria at all locations (see Table 3.5-5) except for the C-4 Canal at the S-25B structure. The MFL performance at this structure is similar to the performance of the 2005 Existing Conditions. In general, with implementation of the project, regional water is available and delivered to avoid exceeding the minimum flow and level canal stage criteria and canal stages are maintained, enabling continued protection of the Biscayne aquifer.

[2] For the Lower East Coast Service Area only deliveries not met for public water supply are tabulated; the percentages do not include meeting supplemental irrigation demands for urban landscaping, nurseries, golf or agriculture in the Lower East Coast Service Area.

[3] Other LOSA combines S-236, S-4, L-8, C-43, C-44, north and Northeast Lake Shore and Lower Istokpoga basins.

Table 3.5-5 Number of Times and Percent of Time Minimum Flow and Level Canal Stage Criteria to Protect the Biscayne Aquifer is not Met

Canal and Structure	2005 Existing Condition (ExPIR)		2005 Existing Condition with EAA Reservoir A-1 (NoRDO/RDO)	
	Number of Times	Percent of Time	Number of Times	Percent of Time
C-15 @ S-40	0	1	0/0	1/1
Hillsboro @ G-56	0	0%	0/0	0%/0%
C-14 @ S-37B	0	1%	0/0	1%/1%
C-13 @ S-36	0	0%	0/0	0%/0%
North New River @ G-54	0	0%	0/0	0%/0%
C-9 @ S-29	0	14%	0/0	14%/13%
C-6 @ S-26	0	19%	0/0	18%/16%
C-4 @ 25B	1	13%	1/0	12%/11%

4.4 OTHER AMENDMENTS

Task 16.15, Appendix 8-25 of the BODR – RCC and Soil Cement Design Mixes Technical Memorandum – follows this Section. The Project Operating Manual is described in Section 7. The updated Opinion of Probable Cost is a completely separate document and is submitted separately.

BLACK & VEATCH

TECHNICAL MEMORANDUM

South Florida Water Management District	B&V Project 140505
EAA Reservoir A-1	B&V File: C-1.12
Work Order No. 2	Issued: January 31, 2006

Task 16.15 RCC and Soil Cement Design Mixes Technical Memorandum - Addendum

To: Distribution

From: Dick Vaeth, Norm Holst, Paul Zaman

1.0 INTRODUCTION

1.1 Background

This Technical Memorandum (TM) provides a summary of materials gradations and quality properties of the aggregate materials used for the Roller Compacted Concrete (RCC) and Soil Cement (SC) design mix testing, and the resulting strengths and cement contents used; and completes the work under Task 16.15. Results of the evaluation of the suitability of on-site rock sources to provide adequate riprap for slope protection were previously summarized in the BODR Appendix 8-25.

This Technical Memorandum summarizes the RCC and Soil Cement SC design mix testing performed using aggregate materials produced on-site during the Test Cell Program construction. This testing was authorized under Subtask 16.15 of Work Order No. 02 TEMPORARY TEST (EMBANKMENT) CELLS - PLANNING, DESIGN, CONSTRUCTION OBSERVATION, MONITORING AND ANALYSIS. The objective of Subtask 16.15 was to evaluate the suitability of available materials for the production of slope protection, filters, and drains. The suitability testing included test crushing and screening to evaluate the stability of the on-site rock to resist breakdown during processing and handling. Laboratory testing was performed to obtain specific gravity, soundness, abrasion, absorption, and strength of the aggregate materials.

Under this memorandum, mix designs for the RCC and SC were performed to verify strengths that can be achieved and corresponding cement contents using the aggregates produced from on-site materials. The information attained will be incorporated into the evaluation of slope protection alternative and the development of probable costs for wave protection of reservoir slopes.

2.0 MATERIALS

Materials used for the preparation of trial design mixes for RCC and soil cement included crushed rock produced from the limestone caprock and select fill produced from the underlying, calcareous, silty sand of the Fort Thompson Formation and a waste sand by product of the aggregate crushing and washing process. Both materials were mined from the seepage canal excavations for the Test Cell embankment construction. The caprock was processed in a portable crushing and screening plant to three gradations to be used in the test cell embankment (riprap bedding, drain material, and filter material). Typical gradations of the crushed rock product produced for the Test Cell construction which were sources of fine and coarse aggregates for the mix designs are given below.

Filter Material:

Sieve Size	Percent passing by weight
½”	100
3/8”	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 50	0-5

Drain Material;

Sieve Size	Percent passing by weight
2”	100
1-1/2”	95-100
3/4”	35-70
3/8”	10-30
No. 4	0-5

Riprap Bedding; 4-inch minus crusher run material which is a screening by-product of the Filter and Drain aggregate materials production.

Soundness and resistance to abrasion testing was completed on each of crushed rock materials, and the results are given in Table 2-1. Material property testing (specific gravity and absorption, ASTM D6473) was also completed on the materials to be used in the mixes, and the results are given in Table 2-2 below.

Table 1 Crushed Rock Product Quality Testing Results

Rock Quality Tests

	LA Abrasion	Soundness
Material	**Loss, %**	**Loss, %**
Filter	26.5	12.9
Drain	29.1	3.3
Bedding	30.2	5.5

Table 2 Results of Material Property Testing

Material	Fine (#4) Sp. Gravity	Percent Passing #4	Coarse (#4+) Sp. Gravity	Specific Gravity	Absorption %
Cement	-	-	-	3.25	-
Fly Ash	-	-	-	2.54	-
Sand	-	-	-	2.71	-
Drain	2.66	4.8	2.44	2.45	4.9
Rip Rap Bedding	-	-	-	2.44	4.0
Select Fill	2.78	87.2	2.25	2.71	12.5

3.0 ROLLER COMPACTED CONCRETE

3.1 Aggregates

Aggregates for the RCC were produced in two gradations shown below by blending two of the crushed rock products, drain and riprap bedding with the sand by-product or select fill: Gradation 1 = 63% Drain + 37% Sand and Gradation 2 = 38% Drain + 27% Riprap Bedding + 35% Select Fill. The minus 2 – ½" sieve portion of the Riprap Bedding was used in the mixture for aggregate gradation No. 2.

	Sieve Size	Percent Passing by Weight
Gradation No. 1:		
	1-1/2 inch	100
	1 inch	70-100
	½ inch	40-65
	No. 4	30-42
	No. 30	11-25
	No. 200	3-10

(Plasticity Index of 4 or less for minus No. 200 fraction)

Gradation No. 2:

2-1/2 inch	100
2 inch	95-100
1 inch	60-85
3/8 inch	42-54
No. 4	30-42
No. 8	23-35
No. 30	10-21
No. 200	4-12

These two aggregate gradations were each used to produce three RCC mixes for each gradation by varying in the proportions of cement and fly ash as shown below (cementitious material content expressed in pounds per cubic yard):

	RCC Design Mixtures A	B	C
Minimum compressive strength =			
28 days	1,500 psi	1,500 psi	1,500 psi
90 days	2,000 psi	2,000 psi	2,000 psi
Minimum cementitious material content =			
Cement	220 lbs.	260 lbs.	300 lbs.
Fly Ash	165 lbs.	195 lbs.	225 lbs.
Total Minimum Cementitious Material	385 lbs.	455 lbs.	525 lbs.
Maximum slump (inches) =	0	0	0
Maximum coarse aggregate size =	See gradations given above.		

The six resulting mixes are designated by the aggregate gradation and cementitious material content using a code: G1 or G2 for the gradation and M-A through M-C for the cementitious material content. As an example is G1M-A was prepared using aggregated gradation 1 (1 ½-inch maximum size) with cementitious material content A (385 lbs/cu.yd.). The constituents per cubic yard of each mix are given in Table 3.

Table 3 RCC Mix Designs

Mix	Cement (lbs/cu. yd.)	Fly Ash (lbs/cu. yd.)	Aggregate (lbs/cu. yd.)	Water (lbs/cu. yd.)
G1M-A	220	165	3524	168
G1M-B	260	195	3576	168
G1M-C	300	225	3633	168
G2M-A	220	165	3513	168
G2M-B	260	195	3565	168
G2M-C	300	225	3622	168

3.2 Initial Testing

The testing began with a series of three point modified proctor testing (ASTM D1557) on each of the six mixes to determine the maximum dry density (MDD) and optimal moisture content (OMC) for each mix. The results are given in Table 4.

Table 4 RCC Mix Modified Proctor Testing Results

Mix	MDD, pcf	OMC, %
G1M-A	130.1	10.6
G1M-B	128.4	9.4
G1M-C	129.7	10.5
G2M-A	125.2	12.4
G2M-B	123.7	12.7
G2M-C	126.4	11.0

This was followed by testing to compare the densities that could be obtained by using two different methods of compacting test cylinders (ASTM C470), a 20-lb Hilti gun rammer method and the ASTM D1557 impact method. The results given below in Table 5 demonstrated that there was no significant difference in the density or strength in the test cylinders obtained by the two methods, so further testing was completed using the Hilti gun rammer method to compact cylinders. The Hilti gun method also produces more uniform results with less effort. Photos of the molded and broken RCC cylinders are attached.

Table 5 Results of RCC Cylinder Compaction Testing

			Curing: 7-days	
Mix	**Method**	**Wet Density (pcf)**	**Strength (psi)**	**Density (pcf)**
G1M-A	Rammer-OMC	141.4	1647	140.9
G1M-A	Hilti - OMC	140.6	991	140.4
G1M-A	Hilti + 3% OMC	137.8	678	137.3
G2M-A	Rammer-OMC	139.3	612	138.6
G2M-A	Hilti - OMC	134.5	822	134.3
G2M-A	Hilti + 3% OMC	135.4	560	135.1

In addition:

1. An extra cylinder of G2M-A, Hilti+3%OMC yielded 511 psi & 134.9 pcf
2. An extra cylinder of G2M-A, Hilti - OMC compacted in 3 layers yielded 1066 psi & 137.9 pcf
3. The higher moisture Hilti cylinders look much smoother with no honeycombing.

3.3 RCC Mix Testing

Three test cylinders were prepared for each of the six mixes using the Hilti gun rammer method of compaction. The mixes proved to be too dry for compaction into the test cylinders molds, so a small amount of water was added to each. The three cylinders for each mix were tested for unconfined compressive strength after curing for 7, 28, and 90 days. The resulting strengths are given in Table 6. The compressive strengths are illustrated graphically for the two mix gradations in Figures 1 and 2. Figure 3 presents the 90-day strengths versus the total RCC cementitious material content.

Table 6 RCC Mix Testing Results

Concrete Mix design	7-day breaks (psi)	28-day breaks (psi)	90-day breaks (psi)	Water Added / 0.075 cubic feet (lbs)
G1M-A	1580	2554	2760	1.02
G1M-B	1600	2424	2940	1.025
G1M-C	1280	2787	2860	1.076
G2M-A	330	2510	2600	1.53
G2M-B	690	1495	1510	0.95
G2M-C	1200	1696	2160	1.125

Figure 1 Gradation 1 RCC Mix Strengths

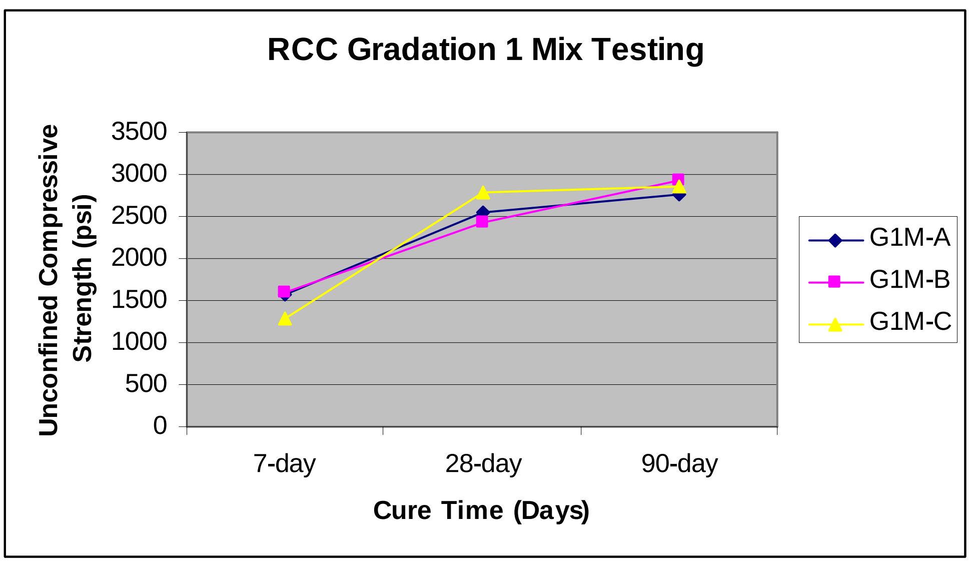


Figure 2 Gradation 2 RCC Mix Strengths

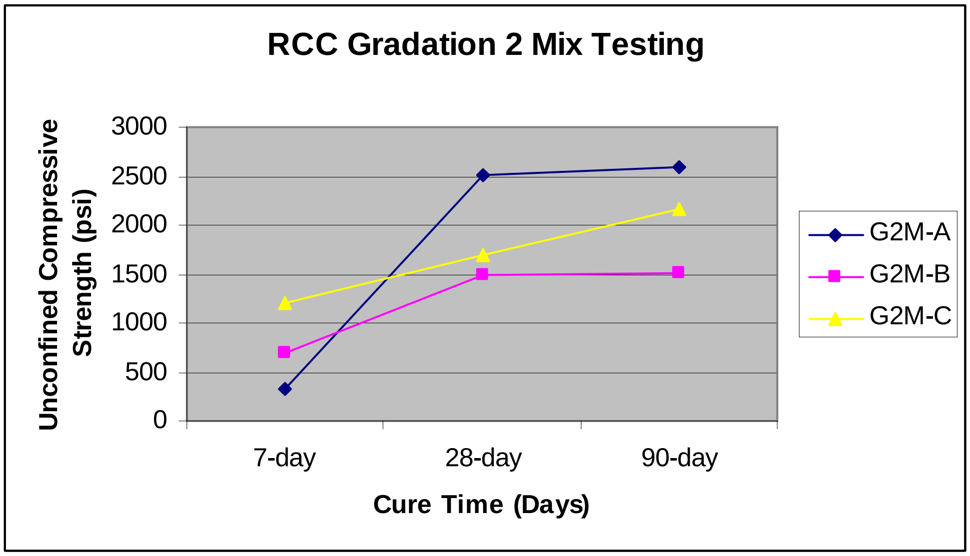
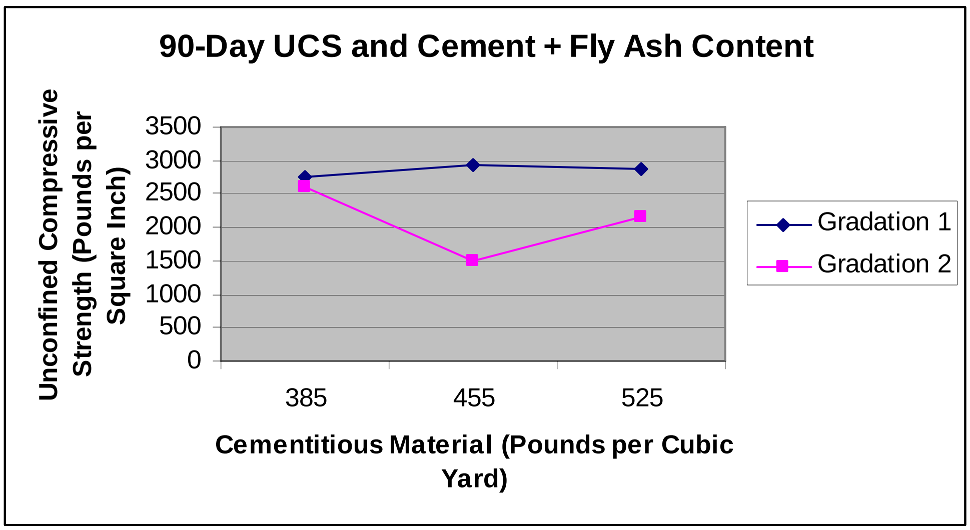


Figure 3 Total Cementitious Material Content and RCC 90-Day Strength



4.0 SOIL CEMENT MIX DESIGN

4.1 Testing Specifications

The specification for the material used in the soil cement mix design included the following:

- Gradation shall be derived from the on-site materials. Materials available are filter material from the aggregate and sand by-product from the on-site processing plant, and silty sand (select material) from the seepage canal excavations.
- Gradation limits shall be:

Sieve Size	Percent Passing by Wt.
1-1/2 inch	100
No. 4	55 – 100
No. 200	15 – 30

- Plasticity Index (PI) shall not be more than 3.

4.2 Mix Design Testing Results

The soil material eventually used for soil cement testing was produced by blending 45 percent select fill and 55 percent waste sand produced by the rock crushing operations at the test cell site. The gradation of the mix was then tested and the cement content necessary to produce a soil cement laboratory compressive strength of 500 psi was determined from the Portland Cement Association Soil Cement Laboratory Handbook. The required cement content was determined to be 6 percent.

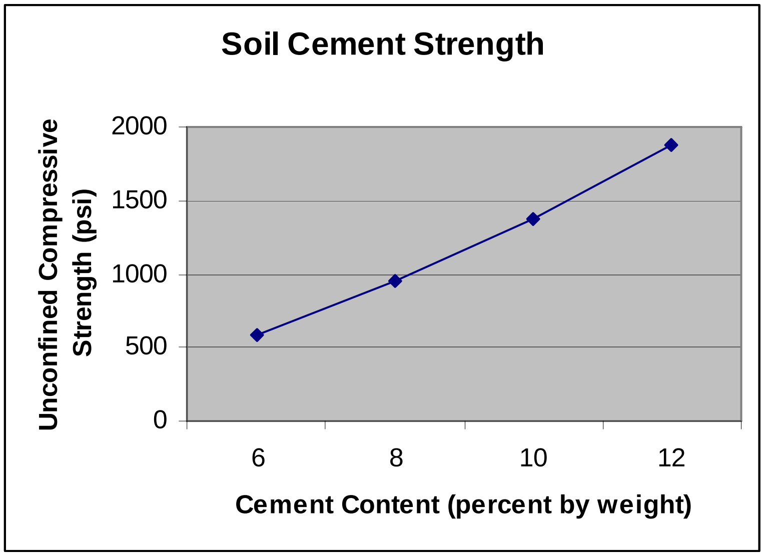
The 6 percent cement mix was tested for the moisture-density compaction relation according to ASTM D558, indicating an optimum moisture content of 16.3 percent and a maximum dry density of 113.3 lbs/cu. ft. The pH of the mix and water to be used for mix preparation were also tested at 8.0. Using the optimum moisture content four test specimens were molded at 6, 8, 10, and 12 percent cement content by weight for unconfined compressive strength testing according to ASTM D 1633 after 7 days of curing. These specimens were also tested for degradation due to wetting and drying (ASTM D559) and freezing and thawing (ASTM D560).

The results of the testing are contained in Table 7 and the 7-day strength is graphed versus cement content in Figure 4.

Table 7 Soil Cement Testing Results

Cement Content (by weight)	Wet/Dry Loss (Ave. of 2 specimens)	Freeze/Thaw Loss (Ave. of 2 specimens)	Compressive Strength (Ave. of 3 specimens)
6 percent	1.5 percent	Less than 1 percent	590 psi
8 percent	Less than 1 percent	Less than 1 percent	950 psi
10 percent	Less than 1 percent	Less than 1 percent	1375 psi
12 percent	Less than 1 percent	Less than 1 percent	1880 psi

Figure 4 Soil Cement Strength versus Cement Content



5.0 CONCLUSIONS

The ASTM C33 maximum loss on soundness testing for fine concrete aggregate is 10 percent when using sodium sulfate and 15 percent when using magnesium sulfate. For coarse concrete aggregate it is 18 percent. The maximum loss on Los Angeles abrasion testing for both small and large coarse concrete aggregate is 50 percent. The Florida Department of Transportation (FDOT) specification for coarse concrete aggregate limits Los Angeles abrasion loss to 45 percent and sodium sulfate soundness testing loss to 12 percent. The concrete aggregates manufactured during the Test Cell Program had soundness and wear losses less than the ASTM and FDOT limits.

RCC manufactured from the on site materials during Test Cell Program met the design strength requirements. There appeared to be no systematic variation in the mix strength with the cementitious material content, but this may be due to the fact that only one cylinder was broken for each mix at the specified cure lengths. It is recognized that small non-homogeneities in the cylinders can affect the tested strengths.

The soil cement mixes manufactured during the Test Cell Program likewise met the design expectations. The Test Cell RCC and soil cement testing program determined that RCC and soil cement suitable for slope protection could be manufactured from materials excavated within the Everglades Project site.

PHOTOGRAPHS

Cylinders Molded for Hilti vs. Rammer Trials

RCC COMPACTION TESTING CYLINDERS


3
2
4
A 3
G2MA
HILTI METHOD
>3%
AA 2
G1MA
@>3%
HILTI METHOD
EAA
G2MA @
HILTI


4
3
2
A 4
G2MA
@OMC
HILTI METHOD
A 3
G2MA
HILTI METHOD
>3%
AA
G1MA
HILTI


5
G1MA @OMC
HILTI METHOD
A
G2MA
@OMC
HILTI METHOD


5
G1MA @OMC
HILTI METHOD
A
G2MA
@OMC
HILTI METHOD


5
G1MA @OMC
HILTI METHOD
G2MA
@OMC
HILTI MET


5
G1MA @OMC
HILTI METHOD
A
G2MA
@OMC
HILTI METHOD


9
6
G2MA >3%
HILTI


9
6
G2MA >3%
HILTI


7
AA
8
G1MA
Rammer
AA
7
G2MA
RAMMER


8
7
AA
8
G1MA
Rammer
AA
7
G2MA
RAMMER


8
AA
G1MA
8

PHOTOGRAPHS

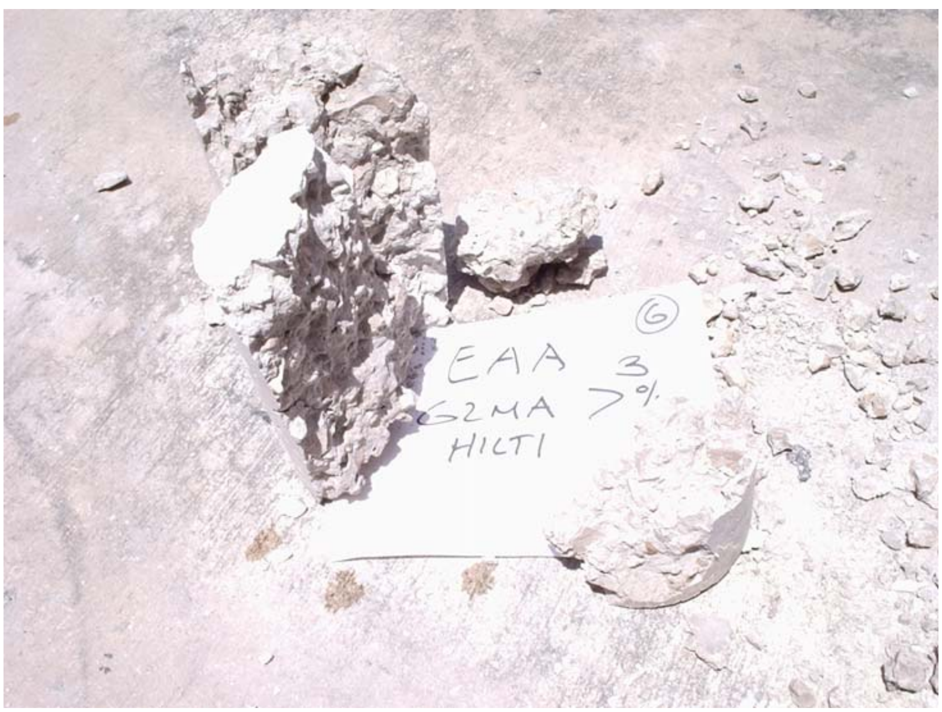
Cylinder Breaks (7-day Strengths) from Hilti vs Rammer Trials

RCC COMPACTION TESTING CYLINDERS BREAKS


AA ③
G2MA
HILTI METHOD
> 3%


Ⓐ
G2MA
@ OMC
HILTI METHOD


EAA ⑤
G1MA @OMC
HILTI METHOD


⑥
EAA 3
G2MA 7%
HILTI


EAA
G2MA
RAMMER

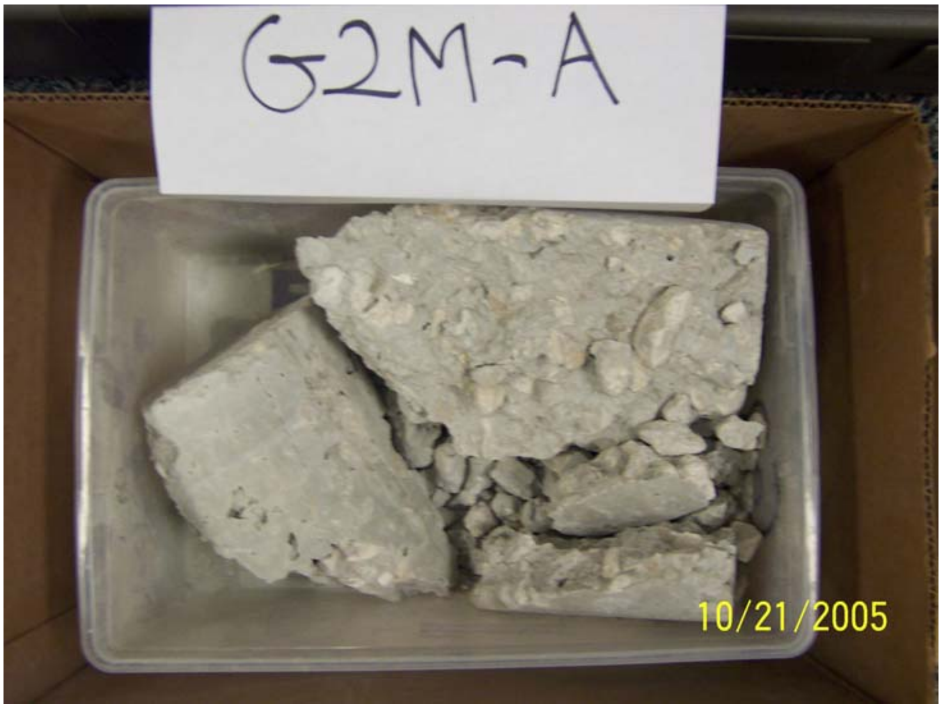

8
AA
G1MA
Rammer

PHOTOGRAPHS

Broken Cylinders from RCC Mix Design (7-day Strength)

RCC MIX TEST CYLINDER 7-DAY BREAKS


G1M-C
10/21/2005


G2M-A
10/21/2005


G2M-B
10/21/2005


G2M-C
10/21/2005

5.0 BASIS OF DESIGN

5.1 EAA RESERVOIR A-1 CHARACTERISTICS

The EAA Reservoir A-1 Project covers approximately 17,000 acres and is designed to store up to 190,000 acre-feet of water at a maximum depth of 12.5 feet. Additional embankment height is provided to accommodate a probable maximum precipitation (PMP) event with accompanying wave run-up and storm surges without overtopping.

The embankment will be a zoned earthen embankment constructed at a 3H:1V side slope with a 12-foot wide crest. Rolled reinforced concrete (RCC) slope protection will be provided on the interior face of the embankment. A 12-foot wide access road will be constructed on the embankment crest and perimeter access roads will be provided at the interior and exterior embankment toe.

An approximately 85-foot wide seepage canal on the exterior of the EAA Reservoir A-1 and an interior borrow canal will also be provided. These canals will supply the material necessary for construction of the embankment.

Descriptions and the basis of design for the embankments, canals, and roadways and other sitework features are included in this section.

5.2 EMBANKMENT DESIGN

5.2.1 Cross-section Configuration

The typical embankment cross-section that will be used for most of the EAA Reservoir A-1 perimeter is shown on Figure 5.2-1. This embankment section utilizes materials from the required seepage canal excavation and borrow excavations with minimal wastage, material sorting or processing. In general, the embankment is comprised of a zoned fill consisting of rockfill, random fill, associated filter drains, slope protection, and seepage control elements. Foundation preparation includes blading the caprock surface to remove muck and clay left after stripping, and brushing the caprock surface using a power broom. A horizontal blanket filter/drain extends over the caprock to relieve seepage pressures and control piping of fine grain materials from the foundation. The horizontal drain discharges into a granular toe drain at the downstream toe of the embankment. Discharge from the toe drain will be concentrated in low areas of the caprock surface. An upstream rockfill section will be produced from the caprock/upper limestone. The random fill consists of silty sand, with some rock pieces (less than 18 inches maximum size), from the Fort Thompson Formation placed without sorting or processing. A transition zone is included between the rockfill and random fill zones. This transition zone will prevent migration of fine grained materials from the random fill into the rockfill due to gravity action or water movement during EAA Reservoir A-1 drawdown or changes in EAA Reservoir A-1 water level. The raked random fill zone (seepage barrier) between the transition zone and vertical chimney is to be free of all rock pieces larger than six inches prior to compaction. The top of this zone extends up to elevation 24.0 feet NAVD88, which is 1.5 feet lower than the maximum normal operating water level in the EAA Reservoir A-1 (Elevation 21.0) plus precipitation from the design storm (4.5 feet). The vertical chimney is provided for internal drainage control by protecting against internal erosion of fine grain materials within the random fill, and by controlling the phreatic line in the downstream random fill zone. Subsurface seepage control will be provided with a soil-bentonite cutoff extending approximately to elevation -35 NAVD88. The soil-bentonite cutoff wall will be located generally beneath the center of the embankment section and extended a minimum of three feet above the caprock surface into the watertight zone between the rockfill and chimney drain. The cutoff trench will be widened through the caprock to allow placement of a lean concrete seal on each side of the cutoff. Top soil (using muck or peat stripped from the embankment foundation) and seeding is provided on the downstream slope. Upstream slope protection is provided by roller compacted concrete (RCC) using an 18-inch layer constructed on the 3H:1V slope extending to elevation 25.1 NAVD88. RCC stepped construction is used above this water level to the crest to provide added wave breaking protection. The embankment crest will be at elevation 35.0 NAVD88 and will be 12 feet wide. The RCC surface will extend across the entire width of the crest and will serve as the primary access roadway.

The embankment sections for the levee along the STA-3/4 Supply Canal are presented in Figure 5.2-2 and Figure 5.2-3. These sections incorporate the existing levee into the downstream toe of the EAA Reservoir A-1 embankment.

The requirement for an internal drainage system to control piping has been eliminated due to the extended seepage path and "back pressure" provided by the water stage in the Supply Canal. The existing seepage canal paralleling the existing levee on the interior, or EAA Reservoir A-1 side, will be filled with compacted silty sand to cutoff the horizontal seepage path through the caprock and the shallow caprock/silty sand foundation material interface. Dewatering of the seepage canal would be required during fill placement.

Figure 5.2-1 Embankment Alternative with Upstream Rockfill Shoulder

No scale

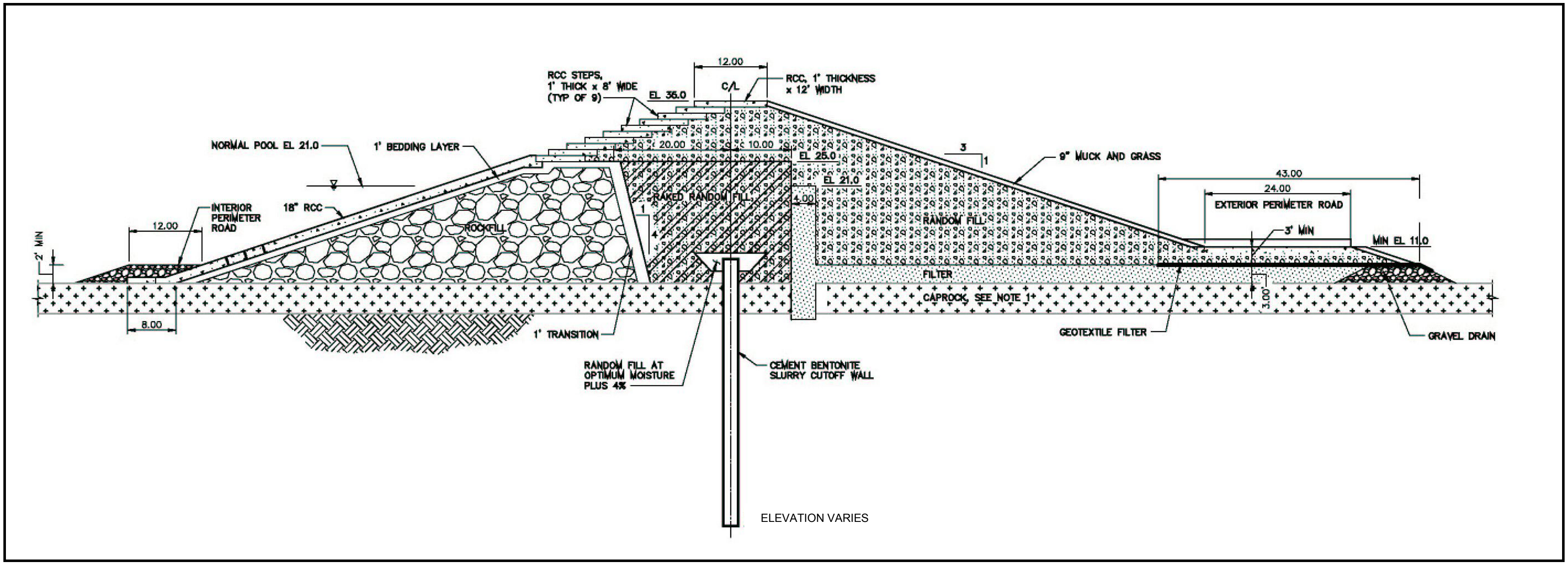


Figure 5.2-2 Embankment Section Adjacent to Supply Canal Levee East of Holey Land

No scale

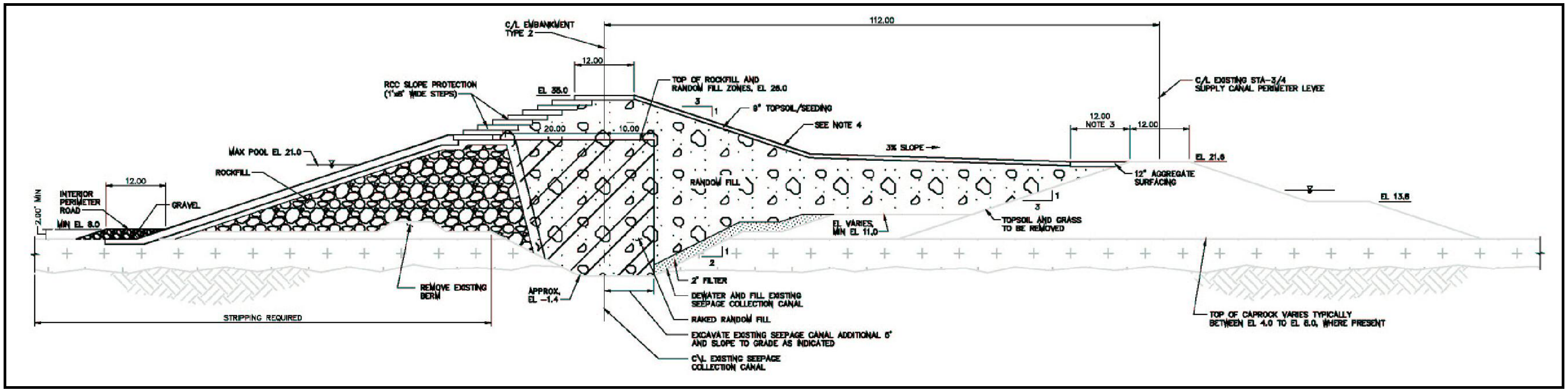
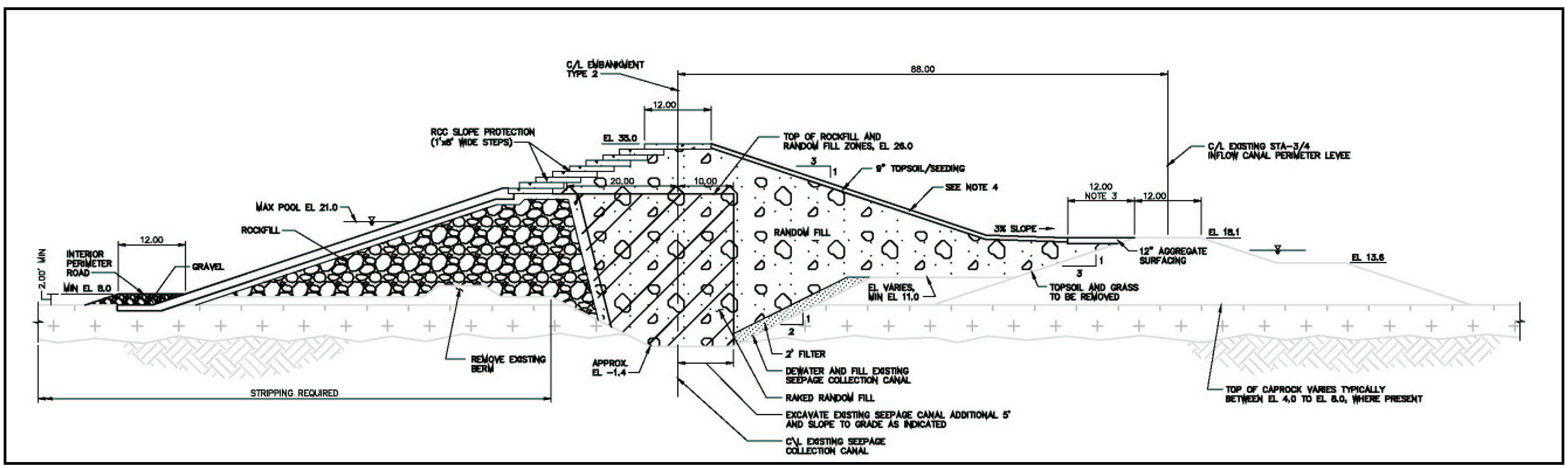


Figure 5.2-3 Embankment Section Adjacent to Supply Canal Levee North of STA-3/4

(No Scale)



5.2.2 Embankment Materials

The EAA Reservoir A-1 embankment design utilizes the available on-site materials to the greatest extent possible. An evaluation of the suitability of on-site materials for embankment construction and erosion protection was made during the Test Cells Construction and Monitoring Program.

The seepage collection canal on the exterior of the EAA Reservoir A-1 embankment is one source of construction material. Additional materials will be obtained from the internal perimeter (borrow) canal and from other borrow areas excavated in the EAA Reservoir A-1 interior.

The embankment design maximizes the use of insitu materials for all the elements of the structure, thereby minimizing the volume of materials that must be imported. The availability of embankment construction materials on site is shown in Table 5.2-1

Table 5.2-1 Availability of Construction Materials

Embankment element	Material	Availability
Seepage barrier	Insitu soils (Fine silty sand excavated from the Fort Thompson formation)	On site
	Bentonite (for a cutoff wall)	Imported
Shoulder support	Insitu soils (Rockfill-caprock and limestone)	On site
Slope protection	Crushed caprock aggregate	On site
	RCC	Imported (cement)
Filter and drain	Crushed caprock aggregate	On site
Gravel drain	Crushed caprock aggregate	On site
Road surfacing and base course	Crushed caprock aggregate	On site

5.2.2.1 Subsurface Profile

The insitu materials at the EAA Reservoir A-1 site have been investigated by a series of borings performed in 2003 and early 2004, borings completed for the Test Cell Program in December 2004 and early 2005, and a series of supplemental boring completed during the summer of 2005.

The generalized subsurface profile defined from the investigation information and used in the embankment design is as follows:

- Surficial peat and marl: The peat (also referred to as "muck") is a black, highly organic, fine grained soil with a variable thickness of one to two feet. In generally isolated areas, the muck is underlain by several inches to two feet of calcareous clay (locally called "marl").
- Caprock/upper limestone (Fort Thompson Formation): Hard limestone layer (generally referred to as "caprock") varying in thickness from zero to about 13 feet across the EAA

Reservoir A-1 site. Thickness in the Test Cell Program site varied from about two to five feet. Much of this layer is solution riddled and commonly sandy or shelly.

- Silty carbonate sand with limestone layers (Fort Thompson Formation): Silty carbonate sand containing shell fragments, tending to be angular and platy, extending to depths below the ground surface of about 23 to 35 feet across the EAA Reservoir A-1 site; average calcium carbonate content is 83.6 percent; average 19.9 percent passing the No. 200 sieve.
- Sand with sparse limestone layers and intervals of hard drilling (Caloosahatchee Formation and/or the Pinecrest Sand Member of the Tamiami Formation): Shelly, uniform, fine-grained, subrounded, quartz sand mixed with shelly carbonate sand starting at a depth of about 23 to 35 feet below the ground surface. Proportions of calcium carbonate to quartz vary greatly; few short intervals of hard drilling less than one foot encountered in some borings; average calcium carbonate content of 36.1 percent and an average of 10.7 percent passing the No. 200 sieve.
- Varying proportions of carbonate and quartz sand (Ochopee Limestone Member of the Tamiami Formation): Fine, uniform, subrounded quartz sand and subrounded, fine to medium grainded carbonate sand with shells and shell fragments starting at about 69 to 73 feet below the ground surface; carbonate content averages 66.8 percent and an average of 11.7 percent passing the No. 200 seive.
- Silty fine quartz sand with shells and shell fragment (Unamed Sand Formation); Silty, fine, uniform subrounded quartz sand with shells and shell fragments starting about 140 to 177 feet below the ground surface: averages 47.5 percent carbonate and 18.2 percent passing the No. 200 sieve.
- Fine to very fine, silty quartz sand grading downward to silt and clay (Peace River Formation): Very fine, silty quartz sand starting about 191 to 200 feet below the ground surface and grading downward to sandy silt and clay at the bottom of the deepest borings; averages 27.2 percent carbonate and 50.2 percent passing the No. 200 sieve.

Detailed descriptions of the insitu materials encountered in the project borings are included in the BODR (Appendix 8-9). Boring logs and associated laboratory testing are included in BODR Appendix 8-17. A program of additional investigation and testing for the EAA Reservoir A-1 Project's design has been completed.

5.2.2.2 Seepage Barrier Materials

The seepage barrier section of the EAA Reservoir A-1 embankments will consist primarily of compacted silty sand from the Fort Thompson Formation.

Test Cell construction demonstrated the feasibility of constructing a zoned earth/rockfill embankment with a water detention zone (select fill) derived from the fine silty sand materials excavated from the Fort Thompson Formation. In the seepage barrier zone of the embankment, rock particles greater than six inches will be raked out of the available silty sands of the required excavations or borrow areas using standard earthmoving equipment and then compacted to form a zone having an estimated permeability limit of 1×10^{-5} cm/s.

5.2.2.3 Rockfill

The rockfill section of a zoned embankment provides the upstream stability of the seepage barrier zone. Rockfill will be obtained from caprock/limestone blasted from the seepage collection canal excavation and internal borrow excavations.

The rockfill gradation for the embankment will have a maximum rock particle size of 24 inches and will be placed with a maximum lift thickness of 30 inches.

Due to the variable caprock thickness and the presence of the underlying silty sand with limestone lenses of the Fort Thompson Formation, it is anticipated that the rockfill after placement will contain a relatively high percentage of particles, by weight, passing the one inch screen. It is expected that the rockfill will have the appearance of a “dirty” rockfill.

The caprock is classified as being a “weak” rockfill due to the quality of the caprock and anticipated high percentage of silty sand materials. The design strength of the rockfill is conservatively selected at a friction angle of 40 degrees.

5.2.2.4 Internal Drainage

The vertical chimney and horizontal blanket drains in the embankment will be constructed of crushed aggregate and will serve to control piping, internal pore pressures, and the location of the phreatic line within the embankment. The horizontal drain section is provided to intercept and collect seepage through the embankment foundation. The chimney drain will intercept seepage through potentially more permeable horizontal layers inherent in the embankment construction preventing saturation of the downstream slope and preventing seepage from exiting the downstream slope above the toe. Flow intercepted through the chimney drain is conveyed to the horizontal drain. Coarse and fine aggregates for use in the internal drainage system can be crushed and screened from the caprock/limestone layer. They will meet filter criteria with the surrounding materials and have sufficient hydraulic capacity to carry the postulated flows.

5.2.2.5 Foundation Drainage

The crushed aggregate horizontal blanket drain is provided to intercept seepage that emerges from the foundation and provides for the controlled release of excess pressure along the foundation contact. Material for foundation drainage will be obtained by crushing caprock that is excavated from internal borrow areas. The blanket drain serves to:

- Relieve uplift pressure caused by seepage
- Permit discharge of seepage water from the foundation
- Prevent piping of fine grained materials from the embankment and foundation
- Convey the seepage to the downstream (or exterior) toe of embankment slope.

5.2.2.6 Roller Compacted Concrete (RCC)

RCC will be used for slope protection on the interior slope of the embankment. RCC was not considered as a watertight membrane on the upstream face of the embankment due to potential cracking from shrinkage inherent in the RCC, potential settlement in the fill, and variable foundation conditions. Crushed aggregate from caprock can be obtained onsite for manufacturing the RCC. However, cement for the mix will need to be imported.

5.2.3 Stability

Stability analyses were performed for the embankment cross-sections discussed above.

5.2.3.1 Material Parameters

The properties of materials modeled in the analyses are shown in Table 5.2-2.

Table 5.2-2 Stability Analysis Parameters

Material Type	γ_T (pcf)	γ_{sat} (pcf)	c' (psf)	φ' (deg)	c_T (psf)	φ_T (deg)	Remarks
Random Fill	120	125	200	34	1000	29	Material from required excavations in Fort Thompson Formation
Transition zone	120	125	0	35	0	35	120
Rockfill[1]	120	125	0	40	0	40	120
Sand Filter	115	120	0	37	0	37	Derived from crushed and processed caprock
Peat	---	65	---	---	100	0	2-foot. layer under existing perimeter levee
Caprock (Limestone)	---	---	---	---	---	---	Not modeled
Silty Sand with Gravel	117	122	0	30	0	30	Foundation. Fort Thompson Formation
Gravelly Sand	120	125	0	35	0	35	Foundation. Caloosahatchee Formation

NOTES:
γ_T – Total unit weight in pounds per cubic foot (pcf)
γ_{sat} – Saturated unit weight in pounds per cubic foot (pcf)
c' – Effective cohesion in pounds per square foot (psf) used in effective stress analysis
φ' – Effective friction angle in degrees (deg) used in effective stress analysis
c_T – Total cohesion in pounds per square foot (psf) used in total stress analysis
φ_T – Effective friction angle in degrees (deg) used in total stress analysis

1. All cases were also analyzed using random fill parameters for the rockfill.

The strength parameters of the embankment random fill were obtained from evaluation of laboratory test results from the Test Cell Program and those described in the Geotechnical Data Report (GDR).

Presumptive strength parameters, consistent with published data, were used to model the rockfill, transition layer, sand filter and the 2-foot thick peat layer that was detected in the boring logs for the perimeter canal levee on the South cross-section.

Foundation strength parameters were obtained from the subsurface investigation boring logs included in the GDR. The boreholes were analyzed for Standard Penetration Test (SPT) blow counts, percentage recoveries and general stratigraphic information with appropriate correlations.

The caprock and the upstream RCC were not considered in the stability analysis for simplicity. These materials will provide additional shear strength for the upstream slope face and the foundation; their omission is conservative. A summary of strength parameters used for all analyses is presented in Table 5.2-2.

5.2.3.2 Slope Stability Results

The calculated factors of safety are based on stability analyses with the Morgenstern-Price method which uses a half-sine function to take interslice forces into account. Analysis conditions for end-of-construction, steady state seepage under NWL (normal pool) and PMP (surcharge pool) conditions, rapid drawdown, and earthquake loading conditions were analyzed. The piezometric surface for the NWL and PMP case was obtained from seepage modeling for the General and South cross-sections using the computer program SEEP/W, version 5.17, by GEOSLOPE International Ltd. For the rapid drawdown case, full drainage was applied to the controlled clean rockfill cases, and no drainage was applied to the cases where rockfill was modeled as random fill. A seismic coefficient of 0.062 was used for pseudo-static earthquake loading. Sliding block stability analyses were also performed on the South cross-section for failure surfaces passing through the 2 ft. peat layer. The results of the stability analysis are listed in Table 5.2-3. All cases analyzed resulted in calculated factors of safety greater than USACE acceptance criteria. The critical sliding surfaces are shown in Figures 5.2-4 through 5.2-17.

Table 5.2-3 Results of Stability Analysis

Case	Strength Parameters	USACE Minimum Factor of Safety*	Factor of Safety	
			Upstream Slope	Downstream Slope
Stability Model - GENERAL				
End of Construction	Total	1.3	2.44 Figure 5.2-4	2.49 Figure 5.2-5
Steady Seepage with Normal Pool	Effective	1.5	-	2.10 Figure 5.2-6
Steady Seepage with Surcharge Pool	Effective	1.3	-	2.08 Figure 5.2-7
Rapid Drawdown from Normal Pool	Effective	1.3	2.12 Figure 5.2-8	-
Rapid Drawdown from Surcharge Pool	Effective	1.1	2.14 Figure 5.2-9	-
Steady Seepage with Earthquake Loading	Effective	1.1	-	1.70 Figure 5.2-10
Stability Model - SOUTH				
End of Construction	Total	1.3	2.21 Figure 5.2-11	5.24 Figure 5.2-12
Steady Seepage with Normal Pool	Effective	1.5	-	3.30 Figure 5.2-13
Steady Seepage with Surcharge Pool	Effective	1.3	-	3.21 Figure 5.2-14
Rapid Drawdown from Normal Pool	Effective	1.3	2.11 Figure 5.2-15	-
Rapid Drawdown from Surcharge Pool	Effective	1.1	2.11 Figure 5.2-16	-
Steady Seepage with Earthquake Loading	Effective	1.1	-	2.60 Figure 5.2-17

* Selected for appropriate load cases from USACE Design Manuals

Figure 5.2-4 End of Construction Upstream Slope

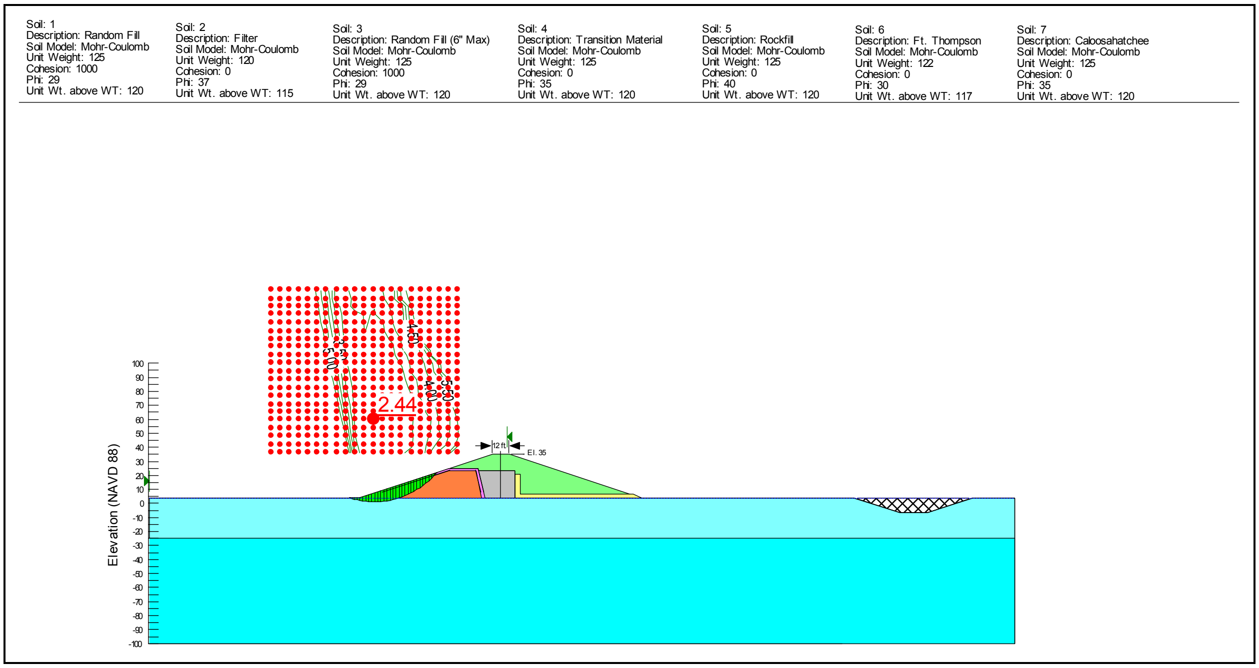


Figure 5.2-5 End of Construction Downstream Slope

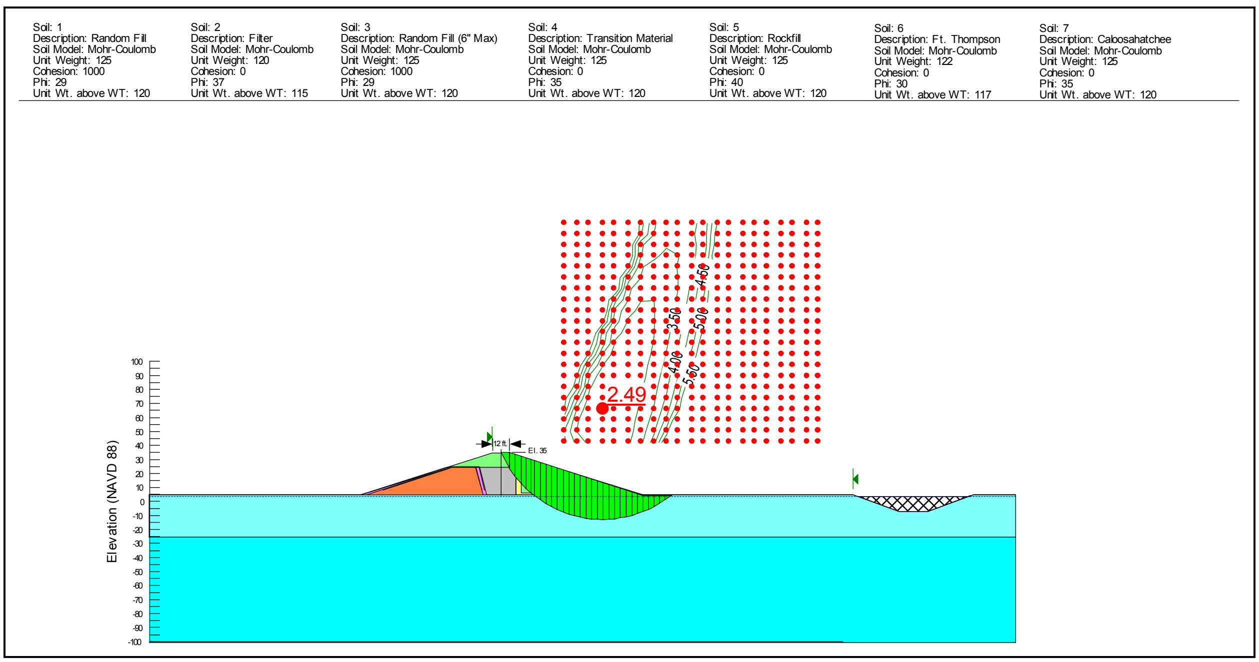


Figure 5.2-6 Steady Seepage with Normal Pool Downstream Slope

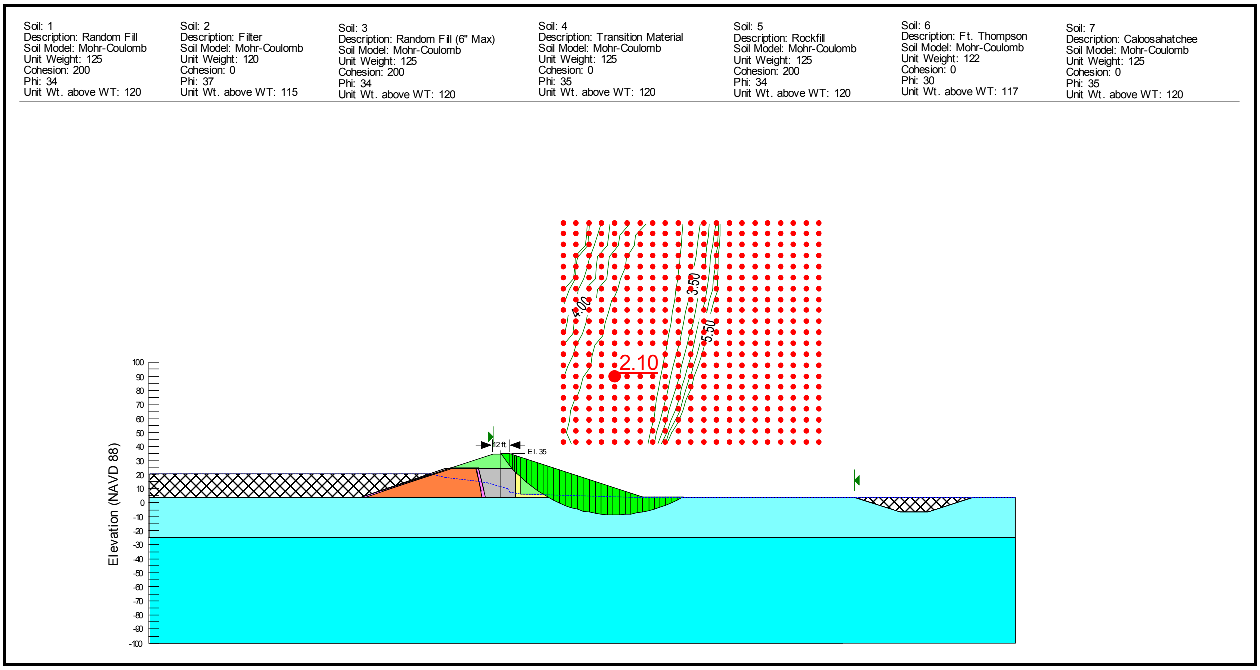


Figure 5.2-7 Steady Seepage with Surcharge Pool

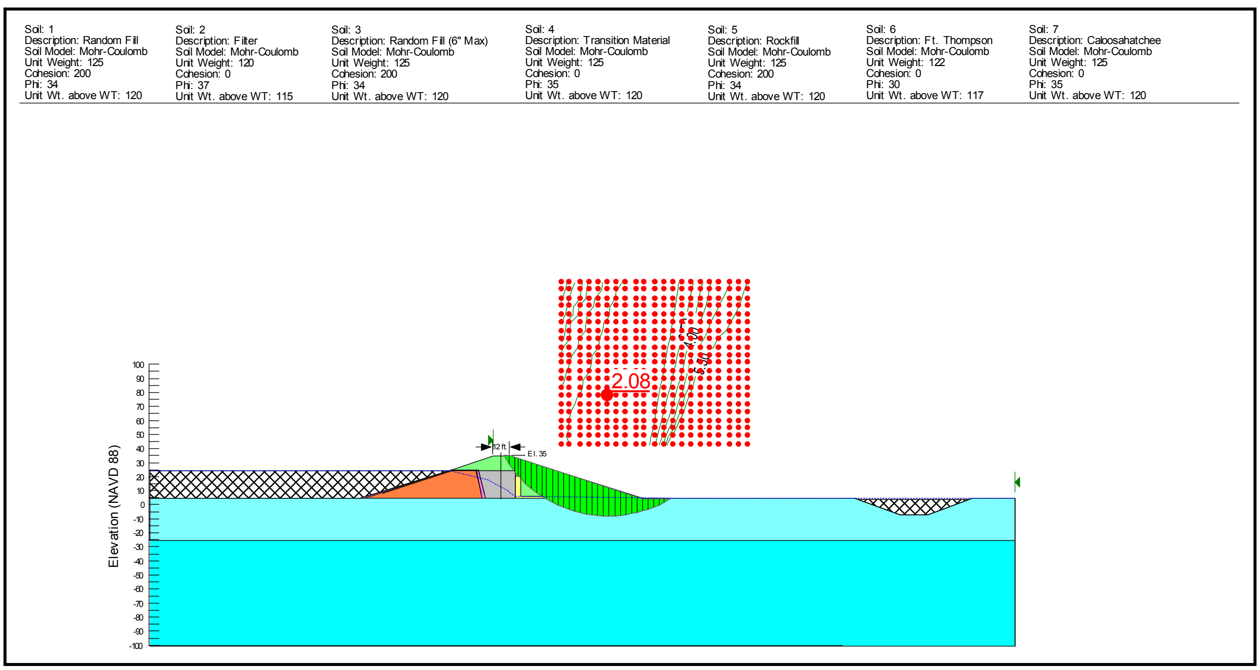


Figure 5.2-8 Rapid Drawdown from Normal Pool Upstream Slope

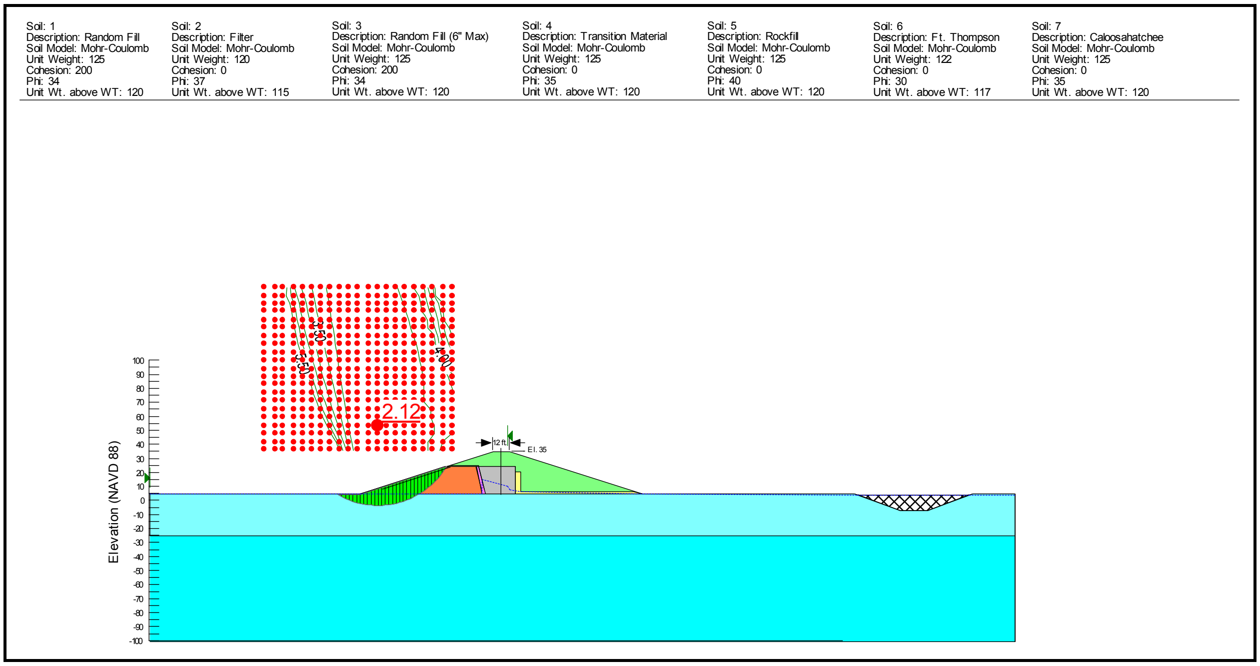


Figure 5.2-9 Rapid Drawdown from Surcharge Pool Upstream Slope

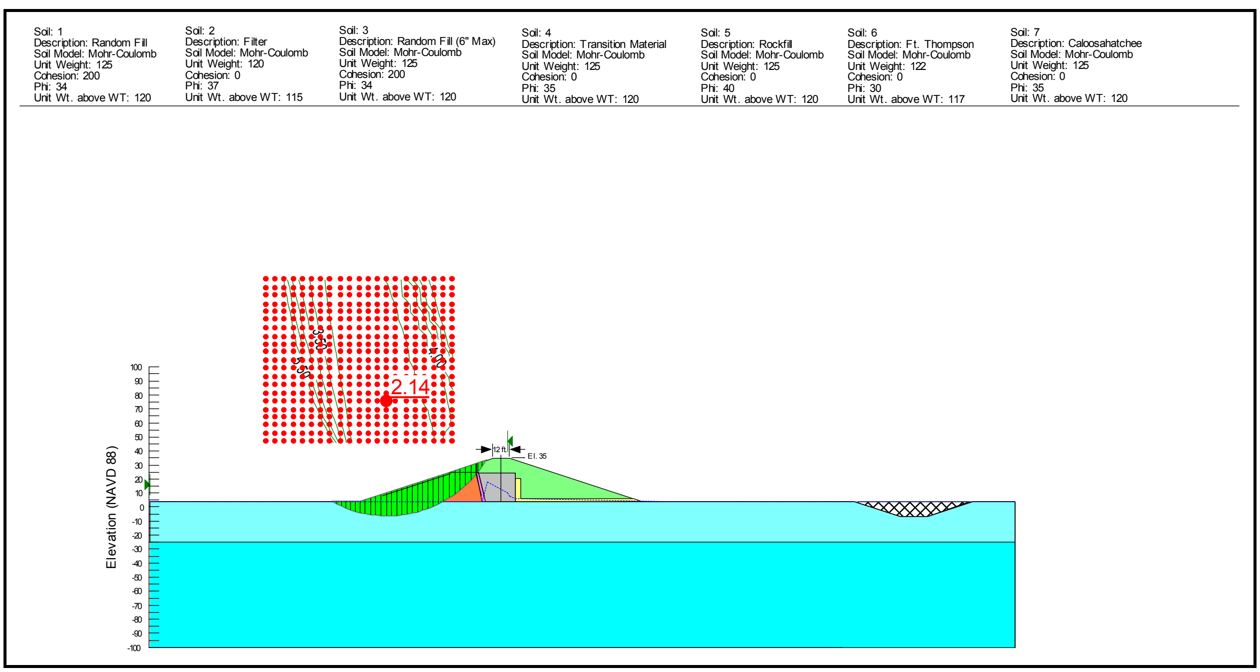


Figure 5.2-10 Steady Seepage with Earthquake Loading

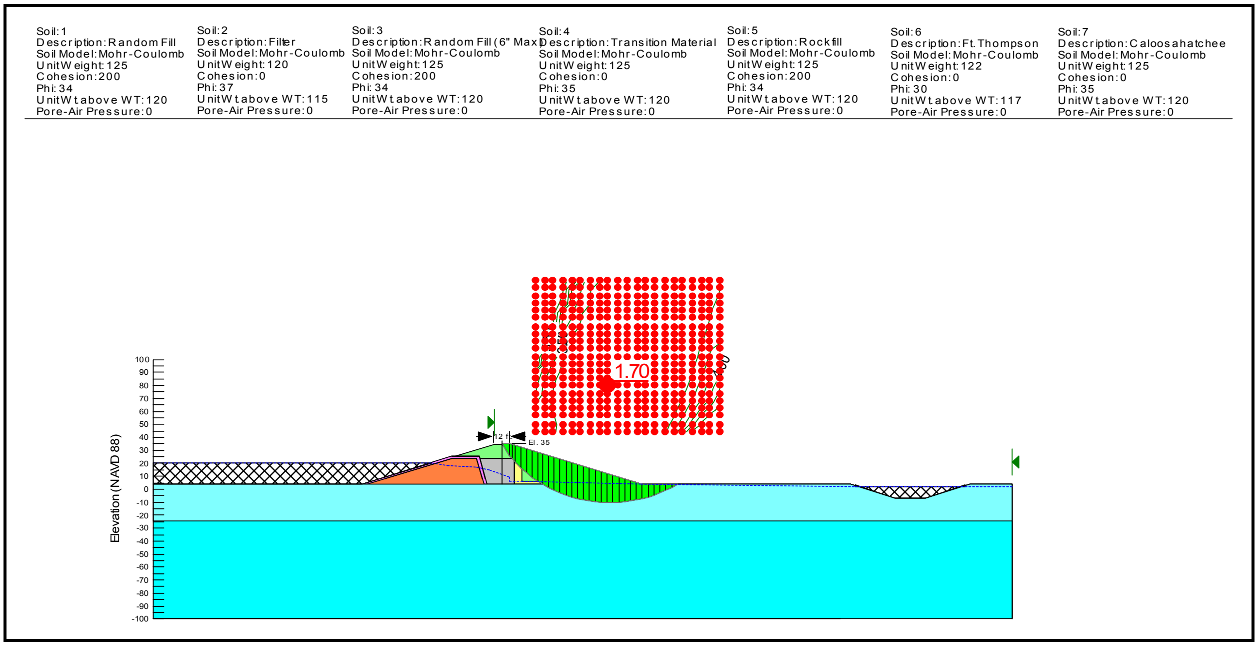


Figure 5.2-11 End of Construction Upstream Slope

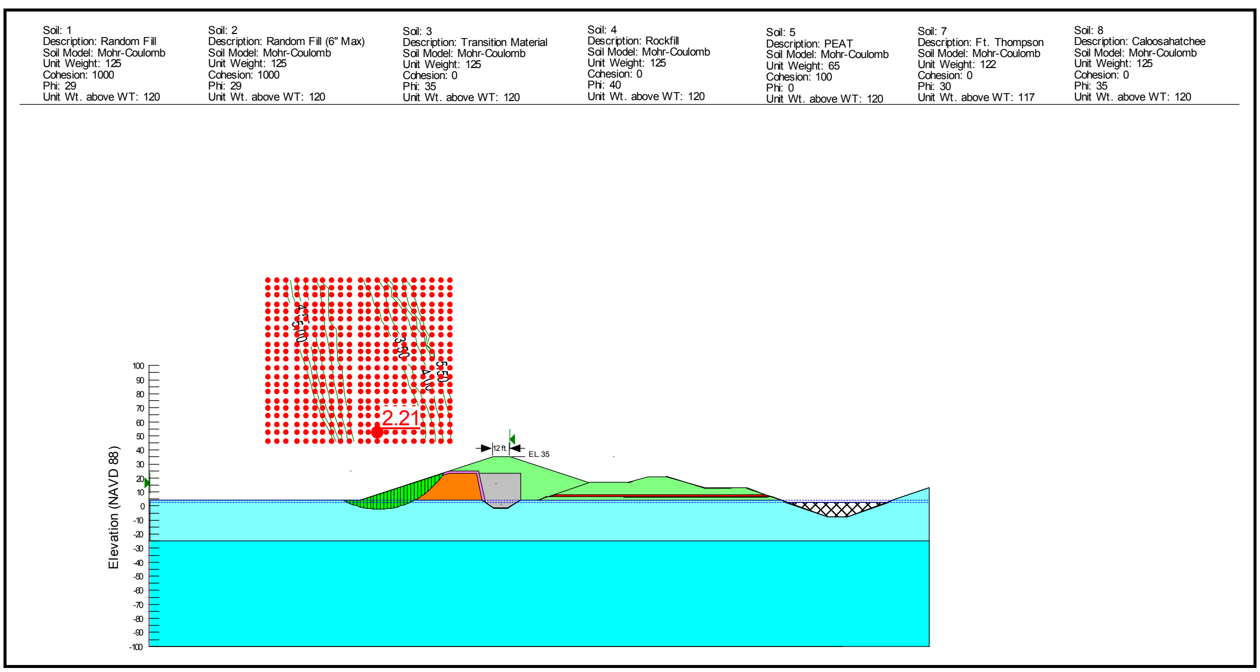


Figure 5.2-12 End of Construction Downstream Slope

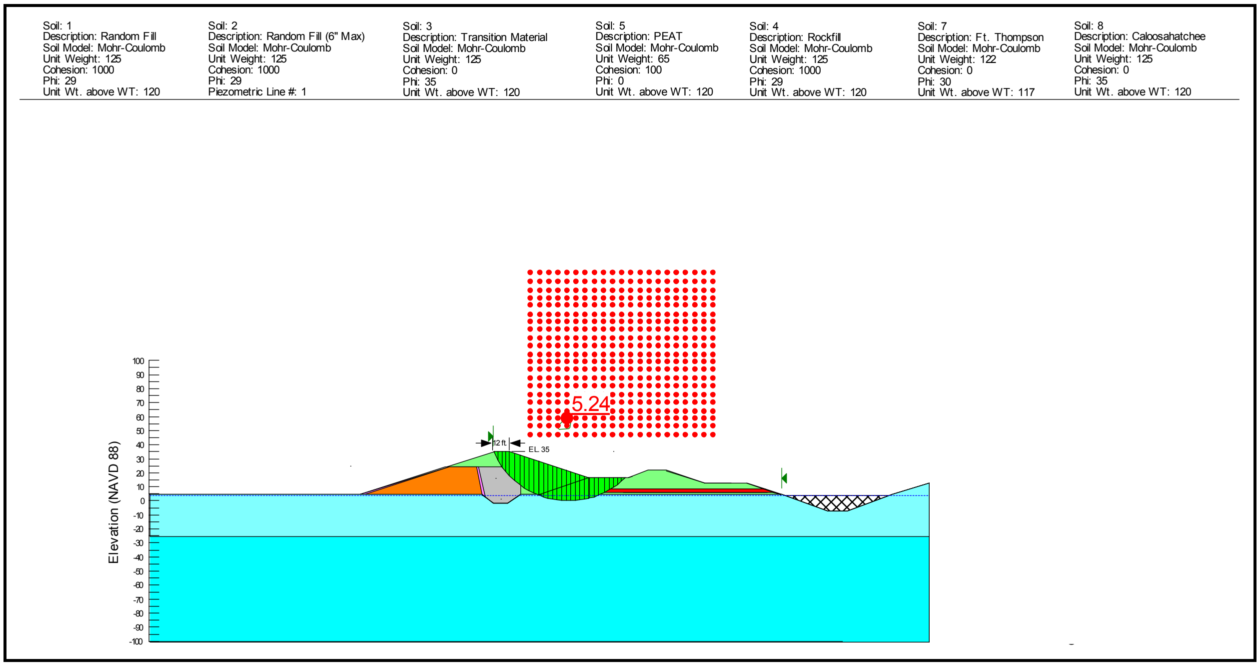


Figure 5.2-13 Steady Seepage with Normal Pool Downstream Slope

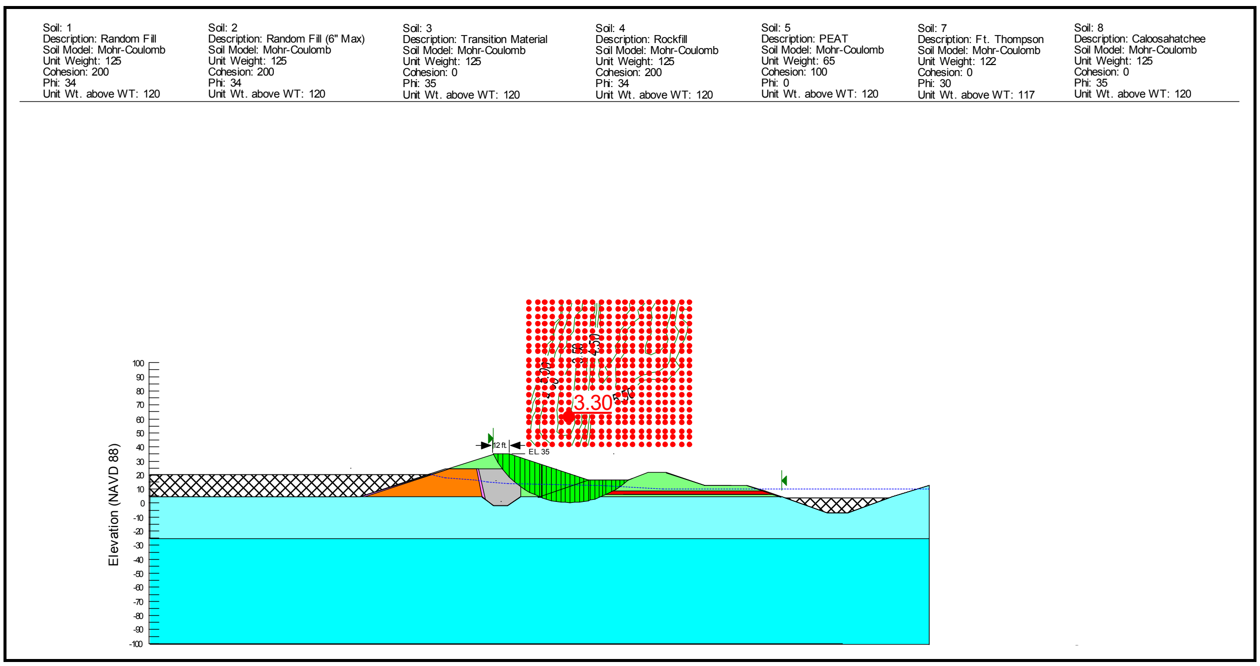


Figure 5.2-14 Steady Seepage with Surcharge Pool Downstream Slope

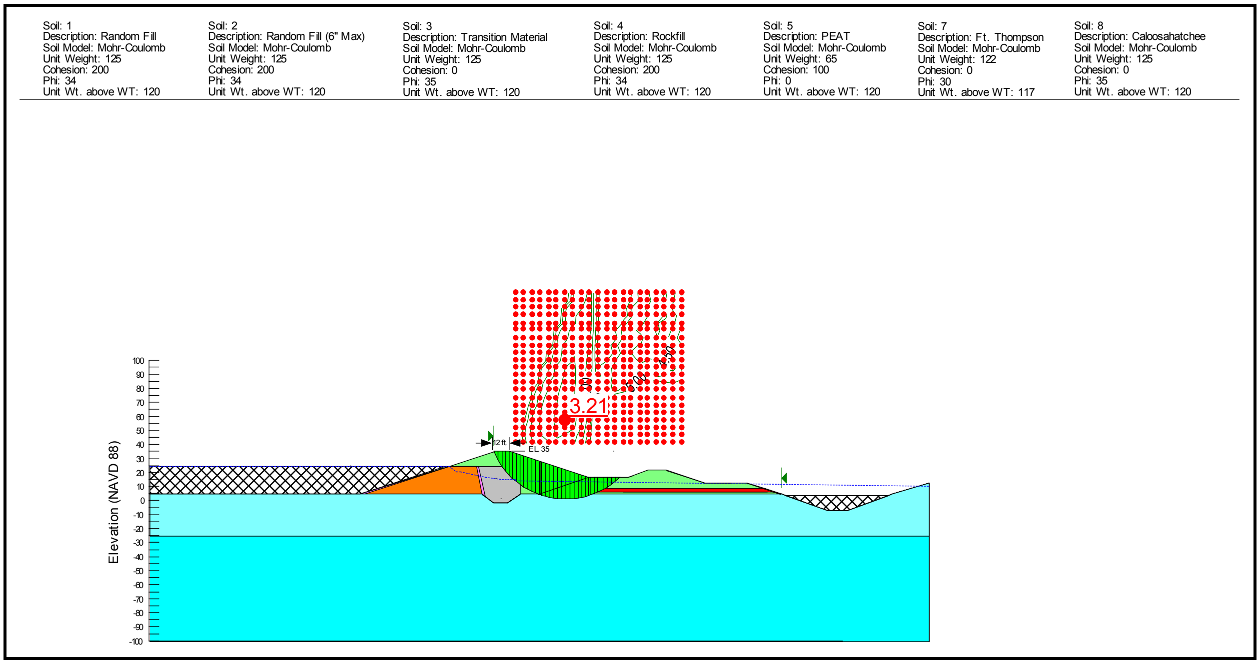


Figure 5.2-15 Rapid Drawdown with Normal Pool Upstream Slope

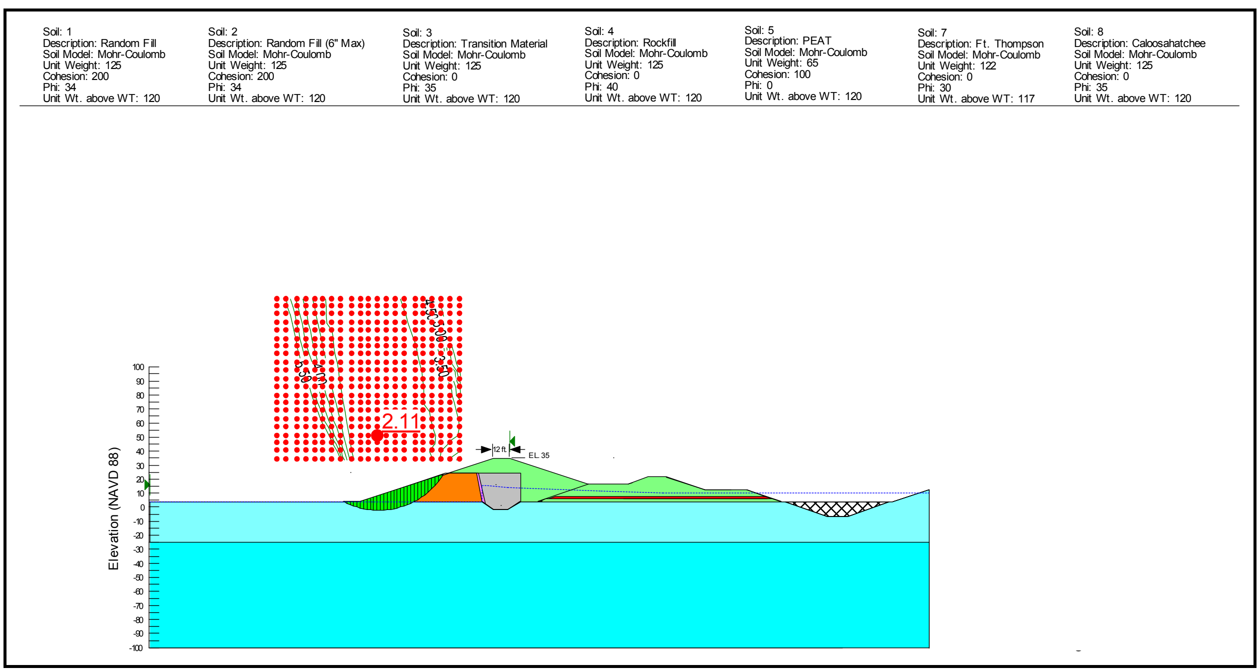


Figure 5.2-16 Rapid Drawdown with Surcharge Pool Upstream Slope

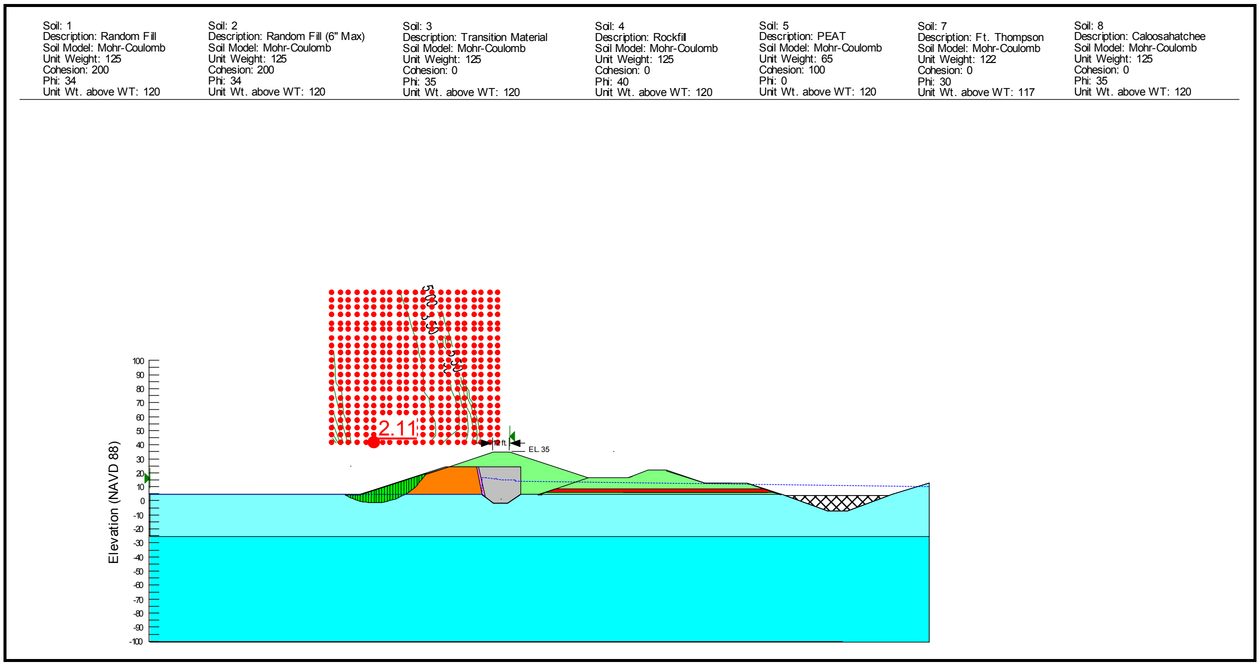
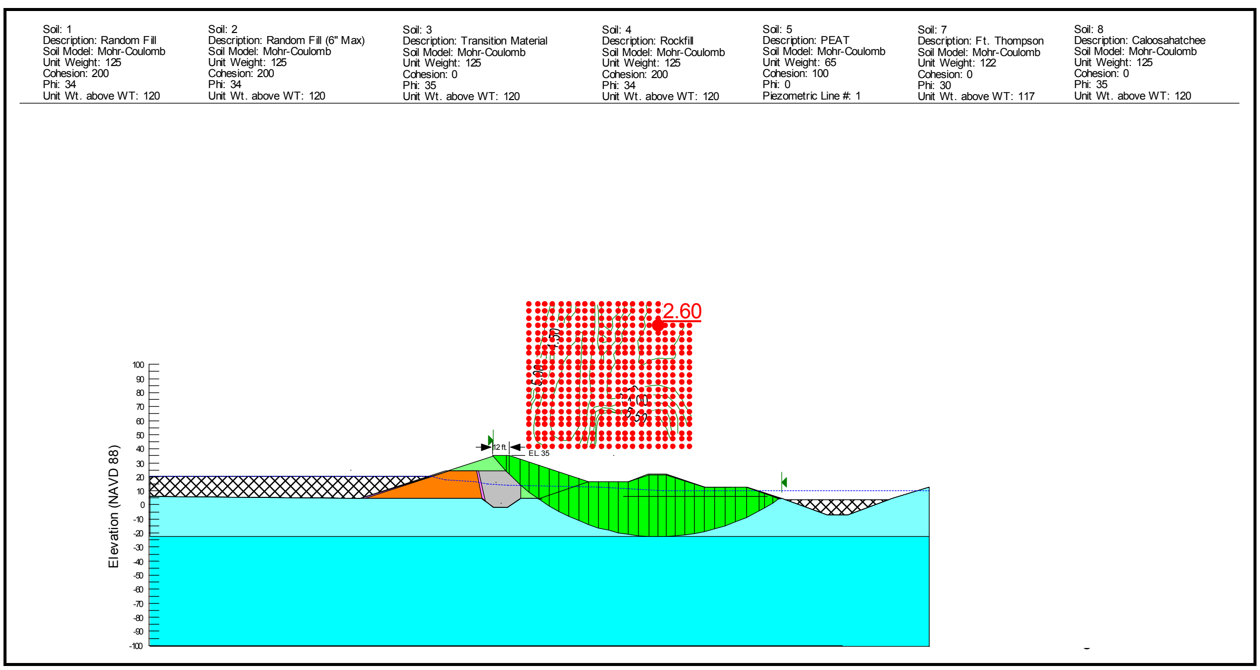


Figure 5.2-17 Steady Seepage with Earthquake Loading Downstream Slope



5.2.4 Erosion Protection

The upstream slope of an earthen embankment must be protected from damage caused by waves; without protection it is possible that the resulting erosion could breach the embankment and cause uncontrolled release of water.

DCM-2 described the criteria and techniques required for evaluation of wave action on CERP impoundments. Wave height studies are described in Section 5.5 and Appendix 5-17 of the BODR. The simplest design solution would be to armor the front of the embankment with a protective material.

RCC is considered the most appropriate means of erosion protection for the maximum height wave predicted for the design wind speed, and combined wind speed and precipitation conditions at the site.

The RCC would be installed on a 3H:1V slope at a thickness of 18 inches from the inner toe of the embankment up to an elevation of 25.1 NAVD88. This elevation is equivalent to the normal maximum EAA Reservoir A-1 water level plus the probable maximum precipitation (PMP). A control joint designed to accommodate shrinkage and control of irregular crack development will be provided at the top of the slope placement.

Above this elevation, a series of horizontal RCC steps 12 inches thick by 8 feet long will extend to the embankment crest to provide protection against breaking waves and wave run-up.

5.2.5 Foundation Seepage Control

The foundation seepage control is provided to mitigate seepage losses from the EAA Reservoir A-1, to protect the foundation from possible damage by piping and minimize excess pore pressures to enhance stability.

5.2.5.1 Cutoff Wall

A cutoff wall will be provided to force seepage to pass vertically downward through low permeability material before it can escape the EAA Reservoir A-1 perimeter. A foundation cutoff will be installed below the water table using the slurry method of trench excavation. The method involves excavating a trench below the groundwater and maintaining trench stability with a dense thixotropic mixture of water and bentonite. The cutoff wall backfill consists of a mixture of the excavated trench soils and processed commercial bentonite.

The caprock at the Test Cell site was observed to have solution voids and channels. Many of the vertical solution channels were circular, ranging in diameter from a fraction of an inch to several inches, and extended all the way through the caprock. The boils that occurred at Test Cell 1 were, primarily, associated with these holes. Bedding planes and more porous layers of limestone are also present between hard and dense layers of limestone within the caprock/upper limestone unit. These porous layers contain horizontal solution channels but the continuity of these channels is not known. The solution voids are generally filled with peat and fine-grained soils. There is a danger that piping could occur through the cutoff wall at caprock level if no protective measure is provided.

In view of the potential for piping, an embankment foundation cutoff wall to an elevation of -22 NAVD88 will be included in the embankment design for seepage control and to ensure stability for the general embankment profile. The cutoff wall will be of soil-bentonite construction and will be 30-inches thick.

The embankment design will make allowance for possible settlement of the material in the cutoff trench.

5.2.5.2 Key Trench Cutoff

A shallower key trench type cutoff is suitable for the embankment section adjacent to the Supply Canal to the north of STA-3/4 and along the east side of the Holey Land Tract due to the downstream hydraulic conditions. The embankment cross-section in this area makes use of the existing STA-3/4 feeder canal embankment and seepage collection canal to extend the length of the seepage path exit and to provide a balancing head against exit pressure. Assessment of seepage during construction of the embankment along the STA-3/4 Supply Canal indicates that the base of the existing seepage collection canal could become unstable because of seepage emerging from the Supply Canal. During construction, the water level in the STA-3/4 Supply Canal will have to be held down adjacent to the fill placing/seepage canal dewatering operation.

5.2.5.3 Perimeter Seepage Collection

The perimeter seepage collection canal will have 2.5:1 side slopes and a depth of 13 feet measured from a caprock elevation of 6.0. The canal floor will be at a uniform elevation of -7.0 for the entire length of the canal.

5.2.5.4 Existing Canal Crossings

The embankment will be constructed across existing canals which are presently used to support agriculture use on the site. Sections of the existing canals will be isolated and cleaned out prior to placing canal backfill to the existing caprock surface. The canal backfill will consist of random fill materials placed to a controlled relative compaction and moisture. The maximum particle size of the random fill to be used for canal backfill will be limited to 6 inches assure that adequate compaction is achieved. The canal backfill will extend continuously from the seepage collection canal to the interior borrow canal. The side slopes of the existing canal will be re-shaped to 5 horizontal to 1 vertical to minimize abrupt elevation changes in the embankment foundation. Special compaction procedures will be used at the caprock faces where re-shaping to a uniform slope cannot be achieved.

5.2.6 Embankment Foundations

Foundation bearing capacity is not a significant consideration for an embankment cross-section at this site. When the embankment crosses local features such as the existing canals, special cleaning and backfill will be required to minimize differential settlement.

5.2.7 Settlement

5.2.7.1 General

Settlement of the embankment crest will occur due to the sum of compression of foundation soils and embankment fill.

The magnitude of settlement is proportional to material stiffness and the stress change caused by construction.

The duration over which settlement occurs varies with permeability. In freely draining material the compression occurs instantaneously; in materials which are slow to drain compression occurs over a longer time scale as excess pore pressures dissipate and pore water is expelled from the soil. The time scale will depend on the permeability of the material and the length of the flow path. Sands are considered to be free draining but thick clay layers can take decades to drain. Silty materials represent an intermediate case and the duration to equalize pore pressures can be highly variable. Where silty layers are thinly bedded with sands, settlement is likely to be more rapid.

Settlement of the embankment crest was estimated in accordance with procedures in the USACE Engineering Manual EM 1110–1-1904.

5.2.7.2 Compression of Embankment Fill

The random fill zone of the embankment will be placed at moisture contents above optimum. Test Cell construction experience demonstrates that excess pore pressures will be generated as a result of the filling operation. Dissipation of these pore pressures, in this thick homogeneous silty embankment zone, will result in settlement of the embankment over an extended period of time. The Schmertman Approximation was used to estimate the magnitude of post-construction settlement of the embankment. A six month period of post construction settlement was assumed.

5.2.7.3 Foundation settlement

As the embankment is constructed, instantaneous (short-term) settlement will occur in the cohesionless foundation soils that underlay the embankment footprint. Standard penetration blow counts from three 180 foot deep borings performed during 2004 were used to estimate the instantaneous settlement using the Schmertman Approximation. In accordance with accepted practice, blow counts were corrected prior to applying the method. This instantaneous settlement will occur during construction of the embankment.

Two of the deep borings, CPO5-EAARS-RB-0283 and CPO5-EAARS-RB-0285 performed by the rotasonic method in 2005, encountered fine grained soil beneath the EAA Reservoir A-1 site. Boring CPO5-EAARS-RB-0285 encountered fine grained soil at a depth of 215 feet to the completion depth of 250 feet. Based on a well log from "Hydraulic Conductivity and Water Quality of the Shallow Aquifer, Palm Beach County," Florida by W.B. Scott, U.S. Geological Survey, Water-Resources Investigations 76-119, fine grained soils have been assumed below Elevation -300 NAVD88. Settlement from the clay layer is not expected to be significant because of small change in stress caused by the embankment at this depth and because of the stress history of the clay layer. Sea level was about 125 meters lower during the Pleistocene geologic epoch than present day sea levels. Therefore, assuming groundwater on the Florida

Peninsula was connected to the sea level change, the clay subsurface soils have been stressed to higher levels than will be imposed by the EAA Reservoir A-1 embankment and are over-consolidated. Over-consolidated clays are relatively stiff up to the pre-consolidation pressure.

5.2.7.4 Results

Table 5.2-4 lists estimated settlement for the EAA Reservoir A-1 embankment.

A settlement allowance of six inches will be built into the embankment crest elevation during construction to compensate for long term settlement. The contractor will have to demonstrate the required embankment crest elevation at the time of substantial completion after which time the SFWMD will monitor and compensate for settlement as necessary in accordance with their dam safety program being developed under DCM-11.

Table 5.2-4 Estimated Settlement for EAA Reservoir A-1 embankment

Description	Approximate Settlement (inches)
Embankment Foundation Instantaneous Settlement During Construction	10
Embankment Post-Construction Settlement	3

5.2.8 Borrow

Material resources to support construction of an earth filled embankment as described previously in this section (excluding bentonite, cement, and additives) are available on site.

5.2.8.1 Rockfill

Material for the rockfill can be obtained from the layer of caprock/upper limestone existing immediately below the surface soils. This layer would be excavated from the seepage canal and is available in borrow area locations throughout the EAA Reservoir A-1 area as needed. Blasting is required to adequately break up this layer for fill material use. The blasting pattern should be selected such that rockfill is produced at the optimum gradation for direct use without processing.

It is currently planned that the blasted material will be hauled to the embankment location and stockpiled either on the interior bench between the embankment and the internal borrow area, or in the location of its final placement in the embankment.

5.2.8.2 Random Fill

Material excavated from the Fort Thompson Formation immediately below the caprock/upper limestone will serve as the source for random fill. In the central zone of the embankment, rock fragments larger than six inches will be removed to develop the water detention zone (water barrier) of the embankment. This sorting will occur on the embankment after initial spreading and before compaction using a “rock rake.” This material is readily available beneath the caprock/upper limestone in all site excavations.

Of importance to the cost of this material is the presence of two layers of limestone within the upper 15 feet of the Fort Thompson Formation. These limestone layers were noted to be of low strength and could be removed with an excavator. Additional handling or raking will be required to remove the larger limestone pieces from the central random fill material zone of the embankment.

5.2.8.3 Drainage Materials

Drainage materials will be obtained by crushing, screening, and washing the excavated caprock/upper limestone to the specified gradation. Since the preparation of the filter and drain materials require the use of a crusher, the source of materials is expected to be the interior borrow areas.

5.2.8.4 Roller Compacted Concrete (RCC)

RCC will be obtained from a central batching plant. Aggregates can be obtained by processing on-site rock materials.

The caprock/upper limestone is suitable as the source of aggregate. Blasting is required to break up the caprock/upper limestone section to suitable size for crushing. Washing will be required to produce materials of the required gradations and quality. It is anticipated that the primary borrow areas for aggregate production will be located within the EAA Reservoir A-1 where caprock is thickest. The contractor will optimize his blasting pattern to facilitate his crushing operation.

Cement for RCC must be imported to the site and properly stored until use.

5.2.8.5 Topsoil

In accordance with SFWMD Design Standards, a 9-inch layer of topsoil will be added to the exterior face of the embankment prior to seeding. Area practice is that this topsoil material is obtained from the local peat, and is available from the stripping and material removed from the embankment construction area. The peat can be stockpiled adjacent to the location of the exterior toe of embankment to reduce handling and cost.

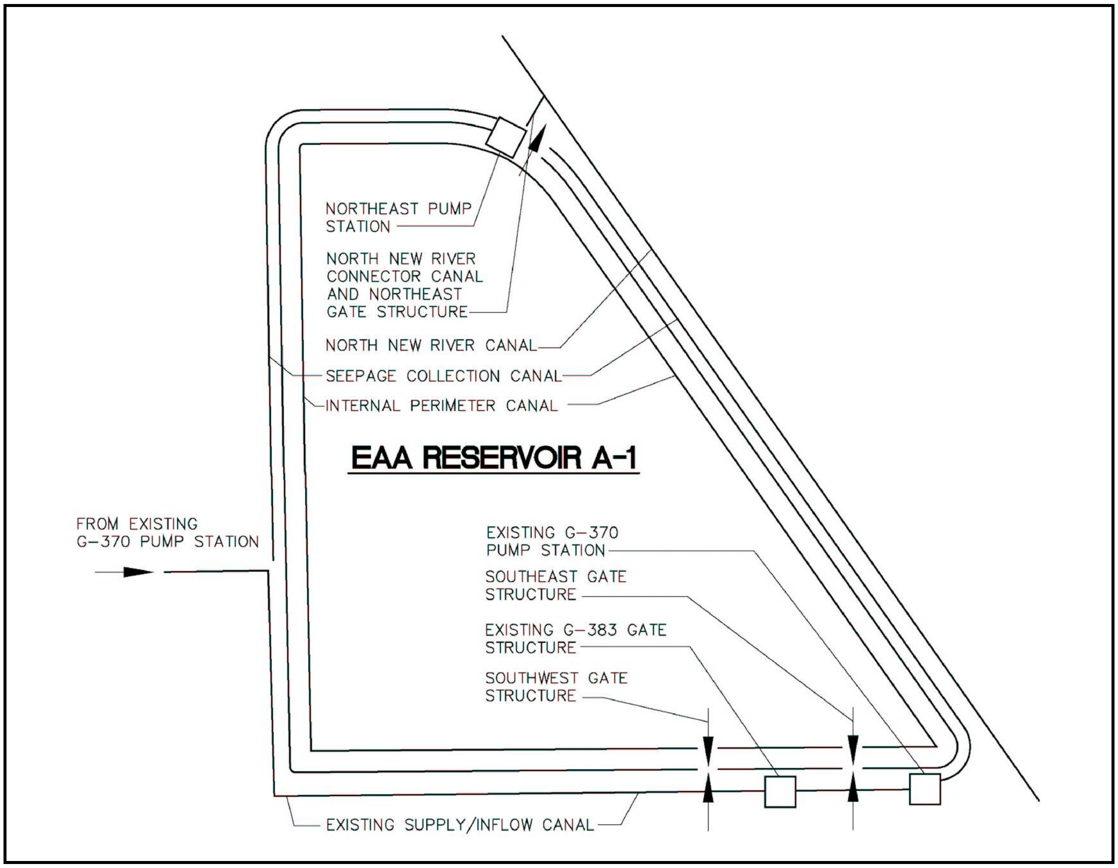
5.3 CANALS

5.3.1 Introduction

Four canals will be constructed as part of the EAA Reservoir A-1 Project. These are shown schematically in Figure 5.3-1. These are:

- Seepage collection canal
- Northeast pump station connector canal
- Internal perimeter borrow canal
- Gate structure canals

Figure 5.3-1 Canals Served by EAA Reservoir A-1



5.3.2 Seepage Collection Canals

The seepage canals around the exterior of EAA Reservoir A-1 will transport seepage from the EAA Reservoir A-1 to seepage pumps located at the northeast pump station. Additionally, the seepage collection canal will be connected to the existing seepage pumps at the G-370 pump station so that those pumps can be utilized in emergency situations. The canal dimensions indicated below were determined based on seepage modeling performed with the intent of minimizing any increase in groundwater levels in the adjacent agricultural areas and on hydraulic calculations for velocities, flows, and hydraulic gradient. The canals will be designed with a constant floor elevation and bottom width throughout its length.

- Canal dimensions
  - 20-foot bottom width
  - 2.5H:1V side slopes
  - Bottom elevation -7.0 NAVD88
- Unlined earthen side slopes with average Manning's "n" value of 0.030
- Minimum of two feet of freeboard and maximum of 3.5 feet of drawdown
- Maximum flow rate of 249 cfs

- Length of longest section of seepage canal is 41,000 feet
- For the Manning's equation calculation, the seepage canal is divided into 10 sections with equal seepage inflow of 13.6 cfs for average depth

Based on the hydraulic analysis of the seepage canals, the hydraulic headloss and velocities are low enough so that erosion of the unlined slopes should not be a problem. Table 5.3-1 presents results (velocity and hydraulic drawdown) for various depths of water in the seepage canal.

Table 5.3-1 Velocity and Hydraulic Drawdown in the Seepage Canal

Average Water Depth (feet)	**Velocity at Pump Station** (feet per second)	**Drawdown at Pump Station** (feet)
8.0	0.47	0.16
7.5	0.52	0.21
7.0	0.57	0.27
6.5	0.63	0.36

Based on area experience and rockfill material production requirements, seepage canal excavation requires blasting of the caprock. Ground vibration and fly rock from blasting is a primary concern along two sides of the EAA Reservoir A-1: the east side paralleling U.S. 27 and electrical distribution lines, and on the south side that abuts SFWMD structures, gate structure G-383 and G-370 pump station.

The centerline of the seepage collection canal parallels U.S. 27 at a distance of about 95 feet from the highway right-of-way line. In general, concrete headwalls for buried drainage structures beneath U.S. 27 and the nearest edge of pavement are about 60 feet inside of the right-of-way. The current published requirements obtained from the FDOT Standard Specifications for Road and Bridge Construction, Section 455-1.1, states the following:

> *…upon detecting settlement or heave of 0.005 feet, vibration levels reaching 0.5 inches/second, levels shown in Contract Documents, or damage to the structure, immediately stop the source of vibrations, backfill any open drilled shaft excavations, and contact the Engineer for instructions.*

A strict interpretation of Section 455-1.1 would have a major impact on blasting procedures adjacent to U.S. 27. Reduced blast hole size, hole spacing, and pounds of explosive per delay or other controlled blasting techniques may be required to meet the stringent velocity limit of 0.5 inches/second.

Based on the blasting experience using a maximum hole loading of 165 pounds and limiting the shooting to one hole per delay at the Test Cell site would require a minimum distance of about 500 feet between the closest shot hole and any FDOT structures to preclude exceeding the maximum vibration requirement of 0.5 inches per second. Considering the same vibration criteria, to shoot within about 110 feet of a FDOT structure and preclude exceeding the vibration limit would require reducing the charge weight per delay to about 9 pounds. Reducing the charge per delay would require drilling smaller diameter shot holes at closer spacing to achieve adequate fracturing or implementation of other controlled blasting techniques such as pre-splitting.

In addition to FDOT structures there are electrical distribution lines along the east side of the EAA Reservoir A-1 site. These are essentially on the west right of way of U.S. 27. The distribution lines would be susceptible to damage from fly rock. Fly rock can normally be controlled with stemming and delay time between the firing of successive rows or, failing that, by using blast mats.

Adequate stemming length increases the weight of the ground over a charge, decreasing the tendency for it to become airborne. If longer stemming leads to unsatisfactory fragmentation near the surface, shallow satellite holes may be necessary. Increasing the delay time between the ignition of successive rows allows the burden for each row to move providing relief for the successive row and again decreasing the tendency for rock to become airborne. Both satellite holes and blast mats increase cost, so stemming length must be balanced to provide surface fragmentation and limit fly rock.

Along the south side the problem is not so critical because only short reaches are near the critical structures. Any special restrictions will only be required within a few hundred feet of the individual structures.

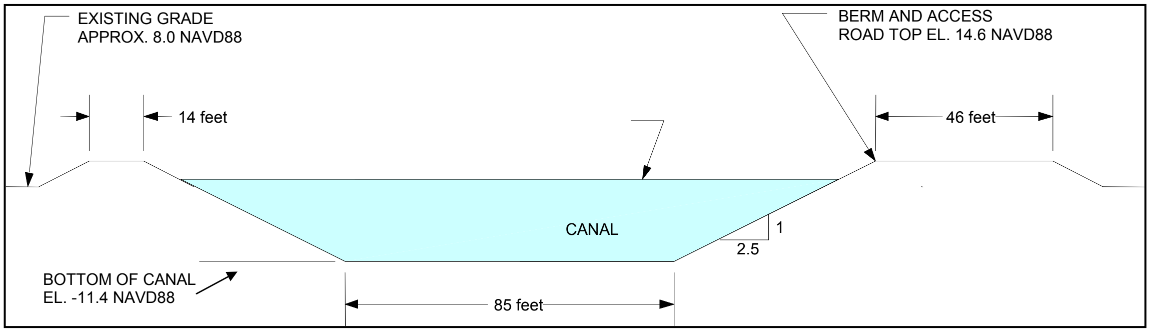
5.3.3 Northeast Pump Station Connector Canal

The connector canal will be constructed from the NNRC to the proposed northeast pump station. The following design criteria were used in order to determine an appropriate cross-section:

- Potential maximum northeast pump station and connector canal capacity of 5,000 cfs
- Potential maximum outflow from the EAA Reservoir A-1 is approximately 1,960 cfs, based on the agriculture deliveries provided by the water balance model
- A minimum straight approach to pump station of 1000 feet
- Side slopes of 2.5H:1V
- Maximum velocity of two feet per second
- Unlined earthen side slopes with an average Manning's "n" value of 0.030 for the entire perimeter
- A minimum water surface elevation in NNRC at pump station of 8.8 NAVD88, with elevation based on HEC-RAS modeling of NNRC
- A maximum water surface elevation in NNRC at pump station of 10.5 NAVD88, with elevation based on HEC-RAS modeling of NNRC
- Bottom of connector canal set at -11.4 NAVD88 (approximately two feet above the bottom of the NNRC at the northeast pump station

A hydraulic analysis of the connector canal indicated that a canal with a bottom width of 85 feet would produce a velocity of less than two fps and would result in a hydraulic drawdown of less than 0.03 feet from the NNRC to the northeast pump station. Figure 5.3-2 shows a typical cross-section through the connector canal. It will be necessary to construct berms above the existing grade on either side of the canal near the pump station, since the surrounding grade of approximately 8.0 NAVD88 is below the maximum canal water level of 11.5 NAVD88. The berms can also serve as a road for maintenance and access. The top of the berms will be at elevation 14.6 NAVD88. The design criteria require that all raised slopes are at 3H:1V for maintenance purposes, and that is sufficient to ensure stability of these low banks.

Figure 5.3-2 Typical Northeast Pump Station Connector Canal Cross-Section



5.3.4 Borrow Canal

The primary function of this canal is to provide material for the zoned EAA Reservoir A-1 embankment and the dimensions are based according to the volumes of material required. The borrow canal extends around the entire perimeter of the EAA Reservoir A-1. The borrow canal will interconnect with existing agricultural canals within the EAA Reservoir A-1, and therefore, improve drainage from the EAA Reservoir A-1 during low water levels. To some degree, the borrow canal will address deep water refugia requested by FWC. The borrow canal and existing agricultural canals would result in about three to five percent of the EAA Reservoir A-1 floor as deep water refugia.

5.3.5 Outlet Structure Canals

Interior canals will be provided to connect the interior perimeter canal to the gate structures along the southern embankment adjacent to the Supply Canal to allow the EAA Reservoir A-1 to be drained. These canals will be designed so that the bottom elevation and width of the canal matches the elevation and width of the outlet culvert or gate structure.

5.3.6 Slope Stability

Preliminary design of below grade canal slopes has been based largely on empirical evidence of existing structures and specific experience from Test Cell construction. Ground conditions comprise caprock over Fort Thompson Formation silts, sands and gravels. Below grade, the canal side slopes are 2.5H:1V.

Internal erosion or piping of fine sands and silts of the Fort Thompson Formation is a potential concern where water emerges from the ground into the new perimeter seepage collection canals. This concern is avoided by limiting the hydraulic gradient at this point using the embankment configuration, cutoff wall beneath the embankment, and distance of the canal from the embankment. A minimum factor of safety of three shall be maintained against this condition.

5.3.7 Seepage Control

In the EAA, water conveyance canals are frequently flanked by seepage collection canals to collect and control seepage. The EAA Reservoir A-1 Project provides new connections with existing water conveyance canals and will increase capacity of existing canals where necessary, but no new canals are included in the Project outside of the EAA Reservoir A-1. In general, existing seepage control measures will be retained adjacent to canals.

The one exception is on the south and southwest side of the EAA Reservoir A-1 where the STA-3/4 Supply Canal's northern levee would be incorporated into a new embankment and the adjacent seepage collection canal would be lost. If the EAA Reservoir A-1 water level is greater than the STA-3/4 Supply Canal water levels, seepage would be from the EAA Reservoir A-1 into the Supply Canal and the STA-3/4. If the EAA Reservoir A-1 water level is lower than the STA-3/4 Supply Canal water level, seepage water will be collected within the EAA Reservoir A-1 and eventually returned to the system. This is an acceptable means of seepage control for the Supply Canal.

5.3.8 Erosion

Flow conditions have been assessed in the NNRC and northeast pump station connector canal. With no modifications, the maximum velocities in the NNRC remain below three fps. Modifications have been proposed that would reduce maximum velocity to less than 2.5 fps and the northeast pump station connector canal would also be designed to this standard. These velocities are sufficiently small to avoid erosion. In addition, should SFWMD opt for increased capacity in the NNRC, the modifications would be made in a manner to ensure low velocities to minimize erosion potential.

In general, it is not expected that erosion protection will be needed for the canal slopes. Early promotion of grass root development and periodic maintenance of canal slopes should result in stable conditions. Protection might be required in specific areas local to structures where velocities might be higher or where geometry might cause a flow concentration.

5.4 SITE CIVIL DESIGN

5.4.1 Setbacks

The configuration of the EAA Reservoir A-1 embankment and seepage canals has been established to achieve storage of 190,000 acre-feet with a design storage depth of 12.5 feet. Setbacks were balanced with the total area available to meet the requirements of SFWMD, USACE, and USFWS, construction considerations, cost, and existing facilities. Alignment and setback for the northern embankment was adjusted to reduce excavation of contaminated soils from the Woerner turf farm area.

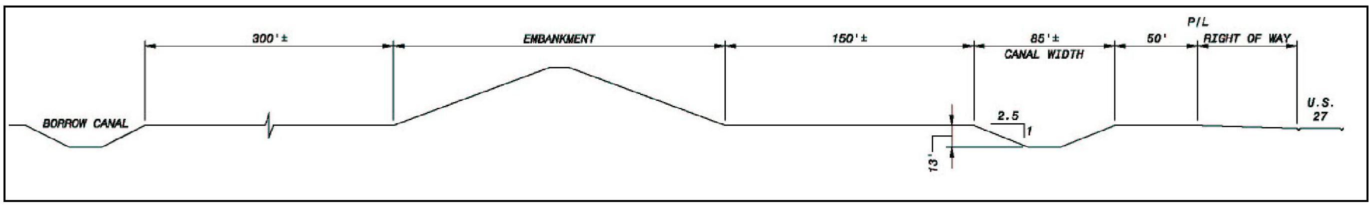
Setbacks for each portion of the EAA Reservoir A-1 are summarized in the following sections. The EAA Reservoir A-1 footprint area is approximately 15,150 acres. Nominal widths for the seepage canals are included in the setback descriptions, based on an average top of caprock elevation of 6.0 and canal bottom elevation of -7.0 NAVD88. A site layout showing the embankment and canal alignments is shown on Sheets 10 through 19 of the Preliminary Drawings.

5.4.1.1 East Boundary (Portion Adjacent to U.S. 27)

See Figure 5.4-1.

- Nominal 50-foot setback from U.S. 27 right-of-way to the seepage canal
- Nominal 85-foot wide seepage canal
- Nominal 150-foot setback from seepage canal to the outside toe of the embankment for exterior perimeter road, construction stockpiling and future wetland areas
- Nominal 300-foot setback from the inside toe of the embankment to the internal borrow excavation

Figure 5.4-1 East Boundary Setbacks

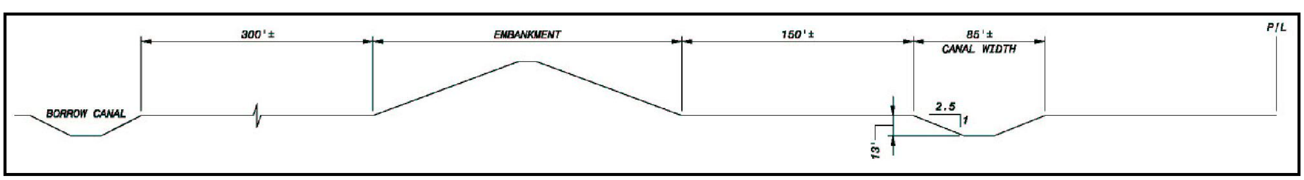


5.4.1.2 North Boundary

The northern embankment will be placed such that the southern edge of the internal borrow excavation is on the southern boundary of the Woerner Turf Farms tract. Therefore, no defined setback from the SFWMD's north property line will be required. The following setbacks will apply to this embankment, as shown on Figure 5.4-2.

- Nominal 85-foot wide seepage canal
- Nominal 150-foot setback from seepage canal to the outside toe of the embankment for exterior perimeter road, construction stockpiling and future wetland areas
- Nominal 300-foot setback from the inside toe of the embankment to the internal borrow excavation

Figure 5.4-2 North Boundary Setbacks



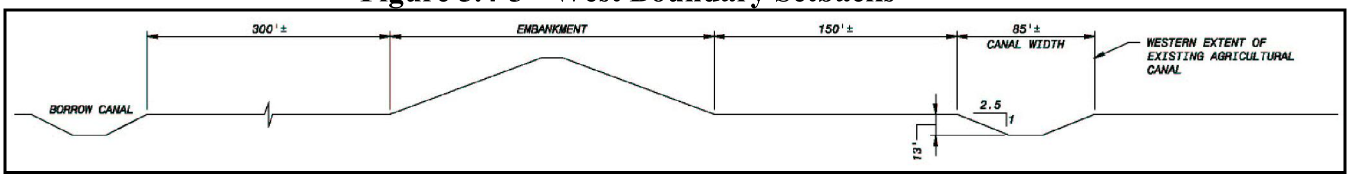
At the northwest corner of the EAA Reservoir A-1, the embankment radius will be increased so that a 150-foot setback from the property corner to the outer edge of the seepage canal can be maintained to provide for future access to the EAA Reservoir A-2 site.

5.4.1.3 West Boundary (Portion Adjacent to Future EAA Reservoir A-2)

An existing agricultural canal is located generally on the boundary between the project site and the future EAA Reservoir A-2 site owned by SFWMD. The seepage canal will be placed such that the western edge of the seepage canal is on the western edge of the existing drainage canal. Other setbacks for this embankment apply as follows and as shown on Figure 5.4-3

- Nominal 85-foot wide seepage canal
- Nominal 150-foot setback from seepage canal to the outside toe of the embankment for exterior perimeter road, construction stockpiling and future wetland areas
- Nominal 300-foot setback from the inside toe of the embankment to the internal borrow excavation

Figure 5.4-3 West Boundary Setbacks

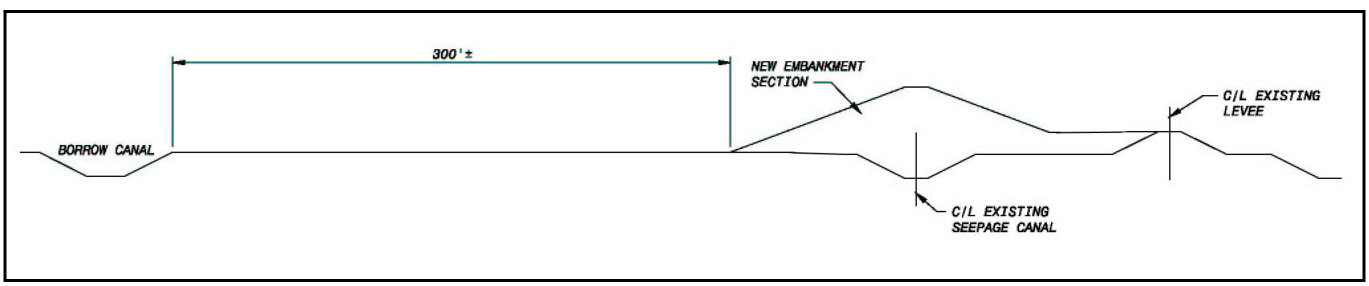


5.4.1.4 South Boundary and South Portion of West Boundary (Adjacent to the STA-3/4 Supply Canal)

For the portion of the embankment along the STA-3/4 Supply Canal, a configuration will be utilized that provides cost-savings and additional storage. Rather than setting back the embankment from the EAA Reservoir A-1 boundary, the embankment will tie in with the northern levee and the eastern levee of the Supply Canal. This embankment, as shown in Figure 5.4-4, is discussed in further detail in Section 8 of the BODR. The following setback would still apply to this embankment.

- Nominal 300-foot setback from the inside toe of the embankment to the internal borrow excavation

Figure 5.4-4 Embankment along STA-3/4 Supply Canal



5.4.2 Site Access and Roadways

5.4.2.1 General

General access to the EAA Reservoir A-1 and associated structures will be limited to SFWMD staff and guests. Public access to the EAA Reservoir A-1 will only be allowed through designated public access points near the northeast and southeast corners of the EAA Reservoir A-1. Public access locations will be designed to support nature based recreation in accordance with SFWMD standards.

The Project is located in an agricultural area and access to the Project site is limited to U.S. Highway 27. Existing gravel and dirt service roads created either by the agricultural interests or by the SFWMD operations and maintenance staff currently provide access through the Project Site. U.S. 27 is a north-south trending four-lane divided highway that borders the entire east side of the EAA Reservoir A-1 and the site for the new northeast pump station. This is a major traffic route for transportation from the Fort Lauderdale area to the central Florida area, and is also a hurricane evacuation route. U. S. 27 will be the primary access route to be used by the contractor during construction. After the Project is complete, U.S. 27 will provide the main access to the EAA Reservoir A-1 and the northeast pump station.

The EAA Reservoir A-1 Project is bordered on the north side by an existing gravel service road used by the agricultural interests. This service road has access to U.S. 27 by way of an existing intersection. The EAA Reservoir A-1 is bordered on the west side by an agricultural area and by the Supply Canal adjacent to the Holey Land WMA. A SFWMD service road is located on top of the existing Supply Canal levee that extends along the southern half of the EAA Reservoir A-1 Project area's west side, and continues east along the southern boundary on the Inflow Canal levee. This service road provides SFWMD vehicle access between the G-372 pump station and the G-370 pump station.

Permanent access on the EAA Reservoir A-1 site will include perimeter roads constructed completely around the top of the EAA Reservoir A-1 embankment, completely around the exterior toe of the embankment between the embankment and the seepage canal, and an internal perimeter road at the interior toe of the embankment. The road along the top of the embankment will be used for access to control structures and for inspection of the inside of the EAA Reservoir A-1. The exterior perimeter road around the embankment will be used for inspection of the exterior embankment slope and toe area. An entrance road from U.S. 27 to the new northeast pump station will serve as one public access road to the site. The existing entrance road to the G-370 pump station will serve as a second public access point.

All vehicular access roads are designed, as a minimum, to meet SFWMD standards, as set forth in the DCMs and as summarized below.

5.4.2.2 Access Roads

The road at the top of the embankment will be 12 feet wide, and will be constructed by extending the upper RCC section across the embankment crest. Access ramps connecting the top embankment road with the exterior perimeter road will be provided at approximately two mile intervals and a 200-foot long, 12-foot wide turnout lane in the roadway on top of the embankment will be provided approximately every one-half mile. Access ramp and turnout surfacing will consist of a six-inch layer of gravel. Turnaround areas with a 50-foot radius will be provided at control structures and other designated structures.

The exterior perimeter road will be 24 feet wide to accommodate two way traffic and will be constructed at the face of the embankment at a minimum elevation of 10.5 NAVD88, approximately one foot above the elevation of the 100-year flood, in accordance with DCM-4. In areas where the elevation of the caprock exceeds the assumed average elevation of 6.0 NAVD88, the road will be raised to allow placement of adequate bedding material. The roadway will have a six-inch thick gravel surface and will be constructed of random fill overlaying a 36-inch thick layer of sand filter material. Side slopes will be 3H:1V with a surface layer of topsoil similar to the embankment exterior slope. The sand filter horizontal blanket above the caprock on the downstream side of the embankment will be extended through the roadway to allow embankment seepage to drain beneath the roadway section.

Along the south and southwest portion of the EAA Reservoir A-1, where the embankment is constructed adjacent to the existing Supply Canal levees, the service road on top of the existing levee will be widened and utilized as the exterior perimeter road. Since the existing road is only about 12 feet wide, it will be widened to a 24-foot width by extending the levee to the north (or east). Surfacing will be a layer of gravel six inches thick. At ramp and turnaround locations, the embankment alignment will be offset toward the inside of the EAA Reservoir A-1 to provide the necessary space on the embankment exterior.

The ramps connecting the top embankment road and the exterior perimeter road will be 24 feet wide, in accordance with DCM-4, and will have a six-inch gravel surface. The maximum slope will be 5 percent. The ramp cross-section will be sloped at 2 percent toward the outside of the embankment to allow surface drainage to flow across the roadway.

A 12-foot wide internal perimeter road will be provided for maintenance access to the EAA Reservoir A-1 interior when the EAA Reservoir A-1 is drained. This road will be located at the toe of the interior embankment and will be constructed of rockfill at a minimum elevation of 8.0 NAVD88. Ramps 12 feet wide with 5 percent slope allowing access to the internal perimeter road from the top embankment road will be provided at the two boat ramp areas and at a point on the western embankment adjacent to the northeast corner of the STA 3/4 Supply Canal. The interior road will be of similar construction and cross-section as the exterior perimeter road.

Access to the perimeter roads from U.S. 27 will be provided at the following locations:

- At the northeast corner of the EAA Reservoir A-1 near the intersection of the existing service road and U.S. 27, adjacent to the public access area and the new northeast pump station
- At the existing G-370 pump station

5.4.2.3 Northeast Pump Station Entrance Road

Access to the new northeast pump station and fuel storage area, boat ramp, and public access parking area will be provided by a new access road from U.S. 27, located near the northern site property line. An existing intersection including acceleration and deceleration lanes and a median crossing will be utilized. The new access road will be 24 feet wide and will have an asphalt driving surface. A site plan showing the access road, pumping station location, and public access area is included on Sheet 20 of the Preliminary Drawings.

5.4.2.4 G-370 Pump Station Entrance Road

At the southeast corner of the site, the existing intersection and access road for the G-370 pump station will be used. The existing road leading to the helipads will be widened to 24 feet to allow two-way traffic and extended to connect with the exterior perimeter road. The roadway surface will be asphalt. An enlarged plan of this area showing the access road, existing pump station facilities, and public access area is shown on Sheet 22 of the Preliminary Drawings.

5.4.2.5 Other Access Roads

Access to the new outlet gate structures in the south embankment along the Inflow Canal will be provided by the perimeter road located along the top of the embankment and by the existing perimeter levee road located along the toe of the embankment's exterior slope. Existing U.S. 27 intersections near the G-370 pump station and near the north site boundary will be utilized for access roads connecting to the EAA Reservoir A-1 perimeter roads.

There are currently other east-west service roads within the boundary of the EAA Reservoir A-1 that have intersections with U.S. 27. These service roads will be removed during the course of the EAA Reservoir A-1 construction, but they may be used for construction contractors' access to the EAA Reservoir A-1 site. Staging areas for the construction of the EAA Reservoir A-1 will be determined by the construction contractors, and may move as construction work progresses. The construction contractor will be limited to entering the EAA Reservoir A-1 Project site from U.S. 27.

It will be the responsibility of the construction contractors to coordinate with FDOT regarding the maintenance of traffic during construction.

5.4.2.6 Boat Ramps

Boat launching ramps for maintenance craft will be provided near the northeast pump station and at the southeast corner of the EAA Reservoir A-1, near the G-370 pump station. Access to these areas will be from the northeast pump station entrance road and the existing G-370 pump station entrance road connections to the upper embankment road. A 24-foot wide interior ramp at a maximum grade of 5 percent will lead to an access area with a boat ramp extending into the water. Sufficient turning area will be provided to allow a vehicle and boat trailer to back down the boat ramp to launch and retrieve a boat.

5.4.3 Bridges and Culverts

The new northeast pump station moves water from the NNRC into the EAA Reservoir A-1 and visa versa. The NNRC runs parallel to and on the east side of U.S. 27. The EAA Reservoir A-1 and northeast pump station are located on the west side of U.S. 27. Therefore, a new connector canal will be required to connect the NNRC to the northeast pump station. A new highway bridge will be required to carry U.S. 27 traffic across the connector canal. Design of the new bridge is not included in this Work Order. However, the location of the bridge and the required bridge opening at the connector canal is shown on the Preliminary Drawings.

The northeast pump station entrance road and vehicular access roads to the southeastern EAA Reservoir A-1 public access point will need to cross the seepage canals. Precast concrete culverts with invert elevations matching the canal bottom and headwalls and/or wing walls, as appropriate, will be provided at these locations.

5.4.4 Stormwater Control/Site Drainage

5.4.4.1 During Construction

A conceptual Stormwater Pollution Prevention Plan (SWPPP) will be required as a part of the contract documents. The objective of the SWPPP will be to prevent erosion where construction activities are occurring, prevent pollutants from mixing with stormwater, and prevent pollutants from being discharged by containing them on-site, before they can affect the receiving waters. The contractors will be required to prepare and submit a comprehensive SWPPP that will be tailored to their sequence of construction. The contractor will be provided conceptual plans, guidelines, and criteria so that detailed drainage plans for all phases and sequences of construction can be prepared.

5.4.4.2 Permanent Construction

The site grading around the new northeast pump station and public access areas will include provisions for capturing the stormwater runoff, where necessary. Long term site drainage along the north and east borders will be directed to the EAA Reservoir A-1 seepage canal. Long term site drainage along the STA-3/4 Supply Canal will be directed to the Supply Canal. Long term site drainage along the west border will either be directed to the EAA Reservoir A-1 seepage canal or to the Miami Canal via existing agricultural canals. Stormwater calculations and facilities will be prepared to comply with local and State guidelines and regulations.

5.4.5 Utilities

5.4.5.1 Electric Power

5.2.5.1.1 Florida Power & Light (FPL) Overhead Distribution Lines

Electric distribution lines are located along the U.S. 27 highway easement. Electric power for the northeast pump station can be obtained from those lines. There are no overhead distribution lines that will need to be removed or relocated for the EAA Reservoir A-1 Project.

5.2.5.1.2 FPL Overhead Primary Lines

There is an existing FPL medium voltage overhead primary line within the EAA Reservoir A-1 Project footprint. This line provides electric power to an agricultural pump station located on the west side of the EAA Reservoir A-1 site. The line will need to be removed and, if a decision is made such that this pump station must stay in operation during and after construction is completed, electric power will need to be re-routed to the agricultural pump station. Black & Veatch will coordinate with the utility owners and obtain input from them regarding utility relocation for design purposes. Demolition of the existing utilities within the EAA Reservoir A-1 footprint is understood to be the responsibility of the utility owner and will be coordinated with the construction contractor.

The new northeast pump station will require a primary power line connected to the distribution line in the U.S. 27 easement. Provision of this line will be included in the work order for the design of the northeast pump station.

The new outlet gate structures to be located along the south embankment of the EAA Reservoir A-1 will require a primary power line. Sources for this power line may include connection to:

- The distribution line in the U.S. 27 easement
- The existing primary line supplying power to the STA-3/4 inlet gates
- The existing primary line supplying power to the G-370 pump station

Provision of the primary power line will be included in the work order for the design of the gate structures.

5.4.6 Site Security

5.4.6.1 Gates/Fencing

SFWMD requires that no public access be allowed within 200 yards of the pump stations. This will be accomplished by fencing the embankment toe-to-toe on each side of the northeast pump station and providing gates at the top embankment road and exterior perimeter road. Existing road fencing and gates will be utilized at the G-370 pump station.

Vehicular access to the top embankment road and the exterior perimeter road will be restricted by gates at the two entrance roads. However, pedestrian, horseback, and bicycle access will be allowed throughout the EAA Reservoir A-1 site, except at the pump stations.

6.0 PERMITTING REQUIREMENTS

Regulatory and permitting requirements within the State of Florida that may be required for the EAA Reservoir A-1 Project were presented in Section 4 of the BODR.

A summary of the permits applicable to the construction of the embankments, canals, and sitework is shown in Table 6-1.

Table 6-1 Federal, State and Local Permitting Requirements

Permit/Approval	Regulated Activity	Agency and Contact	Authority	Approval Timeline*
FEDERAL PERMITTING REQUIREMENTS				
NEPA	Major Federal Action Affecting the Environment	U.S. Army Corps of Engineers Ms. Tori White South Permits Section Office, SESAJ-RD-SS 4400 PGA Boulevard, Ste. 500 Palm Beach Gardens, FL 33410-2933 561-472-3517	40 CFR Parts 1508	12-18 months
Section 404	Fill of wetlands	U.S. Army Corps of Engineers Ms. Tori White South Permits Section Office, SESAJ-RD-SS 4400 PGA Boulevard, Ste. 500 Palm Beach Gardens, FL 33410-2933 561-472-3517	Clean Water Act	Minimum 6 months
Section 401- Water Quality Certification Refer to State/ Approvals	Fill of Wetlands	U.S. Army Corps of Engineers Ms. Tori White South Permits Section Office, SESAJ-RD-SS 4400 PGA Boulevard, Ste. 500 Palm Beach Gardens, FL 33410-2933 561-472-3517	Clean Water Act	Minimum 6 months
NPDES Refer to State Permits Approvals	Wastewater Discharge	Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 33399	CWA	6-12 months

Permit/Approval	Regulated Activity	Agency and Contact	Authority	Approval Timeline*
Endangered Species Act Consultation	Wildlife Impacts	Florida Ecological Services Office 1339 20th Street Vero Beach, FL 32960 772-562-3909 FWC South Regional Wildlife Diversity Ricardo Zambrano Conservation Biologist 850-625-5122 FWC Imperiled Species Management/FWS West Indian Manatee (Trichechus Manatus) Mary Duncan, 850-922-4330	Endangered Species Act	3-6 months
Cultural Resources Refer to State Permits Approvals	Excavation	State Historic Preservation Office R.A. Gray Building 500 Boronough Street Tallahassee, FL 32399-0250	National Historic Preservation Act	60 days
STATE PERMITTING REQUIREMENTS				
Comprehensive Everglades Restoration Plan Act Regulation Act	Project Construction	Florida Department of Environmental Ms. Temperance M. Morgan 2600 Blair Stone Rd., MS 3560 Tallahassee, FL 32399 850-245-8424	Title XXVII Section 373, 373.1502 F.S.	12-18 months
Well Construction	Well Construction	South Florida Water Management District 3301 Gun Club Road West Palm Beach, FL 33406 (561) 686-8800	Rule 40 E-2, F.A.C.	60-90 days
Florida Department of Transportation Access	Bridge and Road Construction	Michael Rippe, Director Southwest Area Office Florida Department of Transportation, District 1 2295 Victoria Ave, Ste# 292 Ft. Myers, FL 33901 (863) 519-2628	Section 40E-6.091, F.A.C.	60-90 days

Permit/Approval	Regulated Activity	Agency and Contact	Authority	Approval Timeline*
Dewatering	Dewatering	South Florida Water Management 3301 Gun Club Road West Palm Beach, FL 33406 561-686-8800	Rule 40 E-20, F.A.C.	60-90 days
NPDES	Stormwater	DEP NPDES Stormwater Program 2600 Blair Stone Rd, MS 2500 Tallahassee, FL 33399 850-245-7522	Rule 62-621 F.A.C	6-9 months
NPDES	Produced Groundwater	Florida Department of Environmental Ms. Temperance M. Morgan 2600 Blair Stone Rd., MS 3560 Tallahassee, FL 32399 850-245-8424	Rule 62-621 F.A.C.	6-9 months
Dam Safety	Embankment Construction	Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 33399	Chapter 373 F.S.	3-6 months
LOCAL PERMITTING REQUIREMENTS				
Development Review Building Permits Zoning Approval	EAA Reservoir A-1 Ancillary Facilities	Planning, Zoning, & Building Dept. Midwestern Office 200 Civic Center Way, Suite 300 Royal Palm Beach, FL 33411 561-784-1300	County Ordinance	3-6 months
Vegetation Preservation and Protection Stormwater Pollution Prevention Permit Wellfield Protection	EAA Reservoir A-1 Ancillary Facilities Construction	Environmental Resource Management Florida Department of Environmental Protection 2600 Blair Stone Rd, MS 3560 Tallahassee, FL 33399	County Ordinance	3-6 months

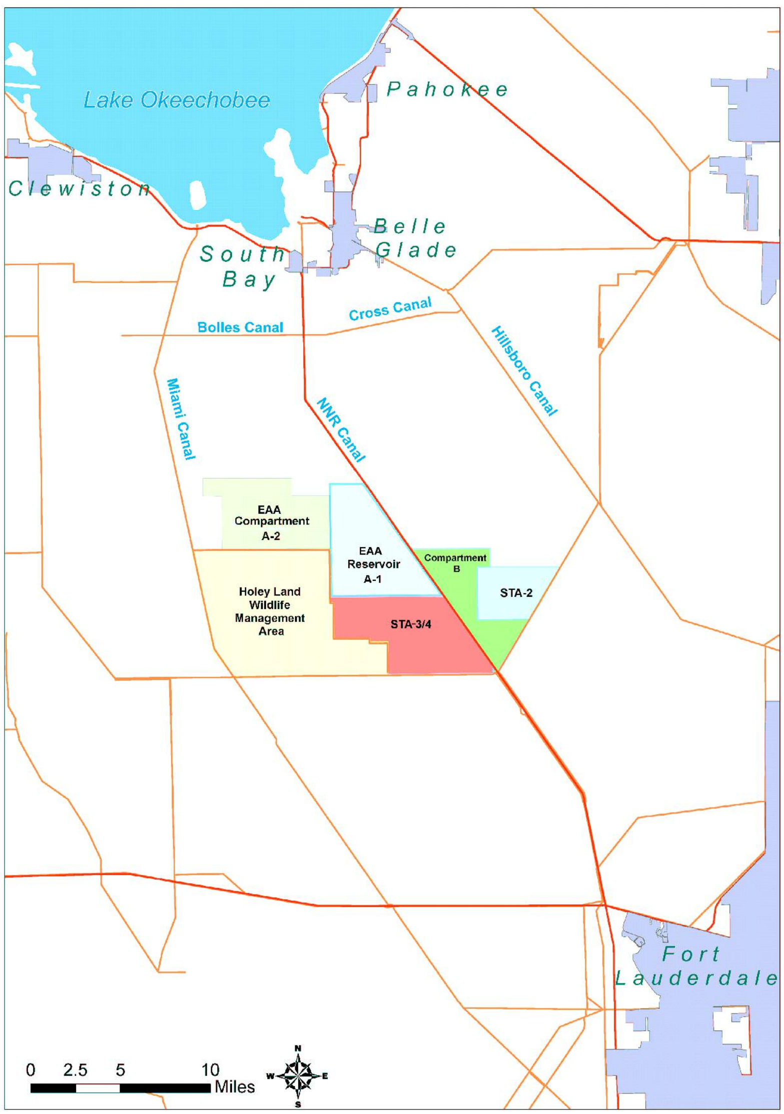
* From the date of permit application submittal.

7.0 DRAFT PROJECT OPERATING MANUAL

7.1 INTRODUCTION

The Project Operating Manual (POM) is for day-to-day water management under essentially all foreseeable conditions affecting the EAA Reservoir A-1 Project. The POM for STA-3/4 is a separate document and is not updated in this document. The draft POM is developed as part of the Preliminary Design of the EAA Reservoir A-1 Embankments Project. Modifications and revisions to the document will occur during the subsequent construction phases. See Figure 7.1-1 for the EAA Reservoir A-1 location.

Figure 7.1-1 EAA Reservoir A-1 Location Map



7.2 GENERAL PURPOSES

The EAA Reservoir A-1 concept was designed to reduce the Lake Okeechobee (LOK) regulatory releases to the estuaries and the backpumping from the EAA into LOK by sending the water to the EAA Reservoir A-1. Additional goals include the following: Improve environmental releases through the storage of water and release to the Everglades during the dry season; flow equalization and optimization of treatment performance of STAs by capturing peak storm event discharges within the EAA Reservoir A-1 for slow release to the STAs; and improve regional water supply to the agricultural community currently served by the EAA canals and other areas served by LOK.

7.3 PROJECT FEATURES

7.3.1 EAA Reservoir A-1

Layout of the EAA Reservoir A-1 includes set backs to the exterior toe of the embankment as follows:

- East – 285 feet from the property line
- North – 2,925 feet from the property line
- West (North of Supply Canal) – the western top of bank of the seepage canal will coincide with the western top of bank of the existing secondary agricultural canal
- West along Supply Canal – the centerline of the embankment will be located 106 feet west of the eastern top of slope of the Supply Canal, such that the EAA Reservoir A-1 embankment top will be directly over the existing seepage canal.
- South – the southern toe of the embankment will be located 14 feet north of the top of bank of the Supply Canal such that the centerline of the EAA Reservoir A-1 embankment is directly over the existing seepage canal.

The EAA Reservoir A-1 is designed for a normal maximum operating depth of 12.5 feet and total storage of approximately 190,000 acre-feet. The perimeter embankment is approximately 108,965 feet long and is 12 feet wide at the crest, with 3H:1V side slope on each side. Total embankment height is 26.5 feet above original grade (OG) to provide for the PMP, wind setup, and wave run-up. Design data for the EAA Reservoir A-1 Project is included in Table 7.3-1.

Table 7.3-1 EAA Reservoir A-1 Project Design Data

Description	Size
Total Surface Area, Acres	15,150
Length of Embankment, Feet	108,965
Total Height of Embankment, Above OG, Feet	26.5
Width of Embankment at Crest, Feet	12
Embankment Side Slopes	3H:1V
Elevation Bottom of EAA Reservoir A-1, Feet	8.6 NAVD88
Normal Maximum Operating Depth, Feet	12.5
Total Storage Capacity, Acre-Feet	190,000 (approximately)

7.3.2 Northeast Pump Station

A new northeast pump station will be constructed near the northeast corner of the EAA Reservoir A-1 to pump water from the NNRC to the EAA Reservoir A-1. The pump station is expected to have six pumps sized for total pumping capacity of 3,600 cfs at full design water level. Some of the pumps will be variable speed to allow them to more closely match the flows in the NNRC to maintain desired canal water level and improve operating efficiency. Design data for the pump station will be determined during the 30 percent design phase for the structures.

Seepage control pumps will be included in the design of the northeast pump station. Seepage canals along the east, north and west sides of the EAA Reservoir A-1 will drain to the northeast pump station where the seepage pumps will discharge into the EAA Reservoir A-1.

7.3.3 Modifications to G-370 and G-372 Pump Stations

For purposes of this draft POM, it has been assumed that G-370 and G-372 pump stations will not be modified to deliver flow to the normal maximum operating pool of the EAA Reservoir A-1. (See Table 7.3-2 and Table 7.3-3for pump and hydraulic description of G-370 and G-372 pump stations) Several pumping alternatives are being considered that would require modifications to one or both of the pump stations, which would result in modifications to the operation scenarios presented in this document.

Table 7.3-2 Pump and Hydraulic Description of G-370 Pump Station

Pump Station Description		Other Notes
Number of Pumps	3	Inflow pumps
Discharge Capacity (each pump)	925 cfs	Pool-to-pool head 7.0 feet. Brake horsepower (Hp) 1182
Design Headwater Elevation	8.6 NAVD88	Headwater varies from 6.6 feet to 12.6 NAVD88
Headwater (HW) Start Up Condition	6.6 NAVD88	50 percent flow @ 23 feet head without vacuum system
Design Low Water (HW) Elevation	6.6 NAVD88	In front of trash screen
Maximum High water (HW) Elevation	12.6 NAVD88	
Maximum Screen Loss to Tailwater At Elevation 16.6 NAVD88	3.6 NAVD88	50 percent flow @ 13 feet head, brake Hp @ 1,315
Design tailwater elevation	13.6 NAVD88	
Maximum Tailwater Elevation	16.6 NAVD88	
Minimum Tailwater Elevation	13.1 NAVD88	
Nominal Pump Operation Speed	113 rpm	
Nominal “On Elevation”	As needed to maintain headwater at or below 8.6 NAVD88	
Nominal “off elevation”	As needed to maintain headwater at or below 8.6 NAVD88	
Motor/Engine Size	935 Hp	Brake horsepower @ rated condition
Motor/Engine Size	1467 Hp	Brake horsepower @ start-up condition
Motor/Engine Speed	720 rpm	Naturally aspirated 2-cycle diesel engine

Pump Station Description		Other Notes
Centerline Discharge Connection	22.6 NAVD88	Discharge sill elevation @ 18.6 NAVD88
Pump Station Floor Elevation	29.6 NAVD88	
Intake Floor Elevation	-9.9 NAVD88	At entrance to Formed Suction Intake tunnel
Discharge Floor Elevation	-5.4 NAVD88	At exit of discharge, tunnel height 12 feet

Table 7.3-3 Pump and Hydraulic Description of G-372 Pump Station

Pump Station Description		Other Notes
Number Of Pumps	4	Inflow pumps
Discharge Capacity (Each Pump)	925 cfs	Pool-to-pool head 9.0 feet. Brake Horsepower (Hp) 1182
Design Headwater Elevation	8.6 NAVD88	Headwater varies +6.6 to + 12.6 NAVD88
Design Low Water (Headwater) Elevation	6.6 NAVD88	Headwater level in front of screen
Start-Up Headwater Elevation	6.6 NAVD88	50 percent flow at 16.0 feet pool-to-pool Hd.
Maximum High Water Headwater Elevation	12.6 NAVD88	
Maximum Screen Loss Headwater Elevation	3.6 NAVD88	50 percent flow with tailwater elevation 17.6 NAVD88
Design Tailwater Elevation	15.6 NAVD88	
Maximum Tailwater Elevation	17.6 NAVD88	
Minimum Tailwater Elevation	13.1 NAVD88	
Nominal Pump Operation Speed	119 rpm	
Nominal “On Elevation”	As needed to maintain headwater at or below 8.6 NAVD88	
Nominal “Off Elevation”	As needed to maintain headwater at or below 8.6 NAVD88	
Motor/Engine Size	1663 Hp	Start-up condition
Motor/Engine Speed	720 rpm	2 cycle diesel naturally aspirated
Centerline Discharge Connection	22.6 NAVD88	Discharge sill elevation at 18.6 NAVD88
Pump Station Floor Elevation	29.6 NAVD88	
Intake Floor Elevation	-9.9 NAVD88	At FSI tunnel entrance
Discharge Floor Elevation	-5.4 NAVD88	At exit of discharge, tunnel height 12 feet

7.3.4 EAA Reservoir A-1 Gate Structures

7.3.4.1 Supply Canal Gate Structures

Two EAA Reservoir A-1 gate structures will be provided for discharge from the EAA Reservoir A-1 to the Supply Canals feeding the STA-3/4. (see Table 7.3-4 for Inflow/Supply Canal, Levee, Hydraulic Parameters, and Figure 7.3-1 for the EAA Reservoir A-1 Control Structures Location Map). One structure (southeast gate) will be located in the south EAA Reservoir A-1 embankment between G-370 pump station and control structure G-383. The second structure (southwest gate) will be placed on the west side of the EAA Reservoir A-1 at the location where the Supply Canal turns south and parallels the EAA Reservoir A-1 embankment before joining the Supply Canal.

Figure 7.3-1 EAA Reservoir A-1 Control Structures Location Map

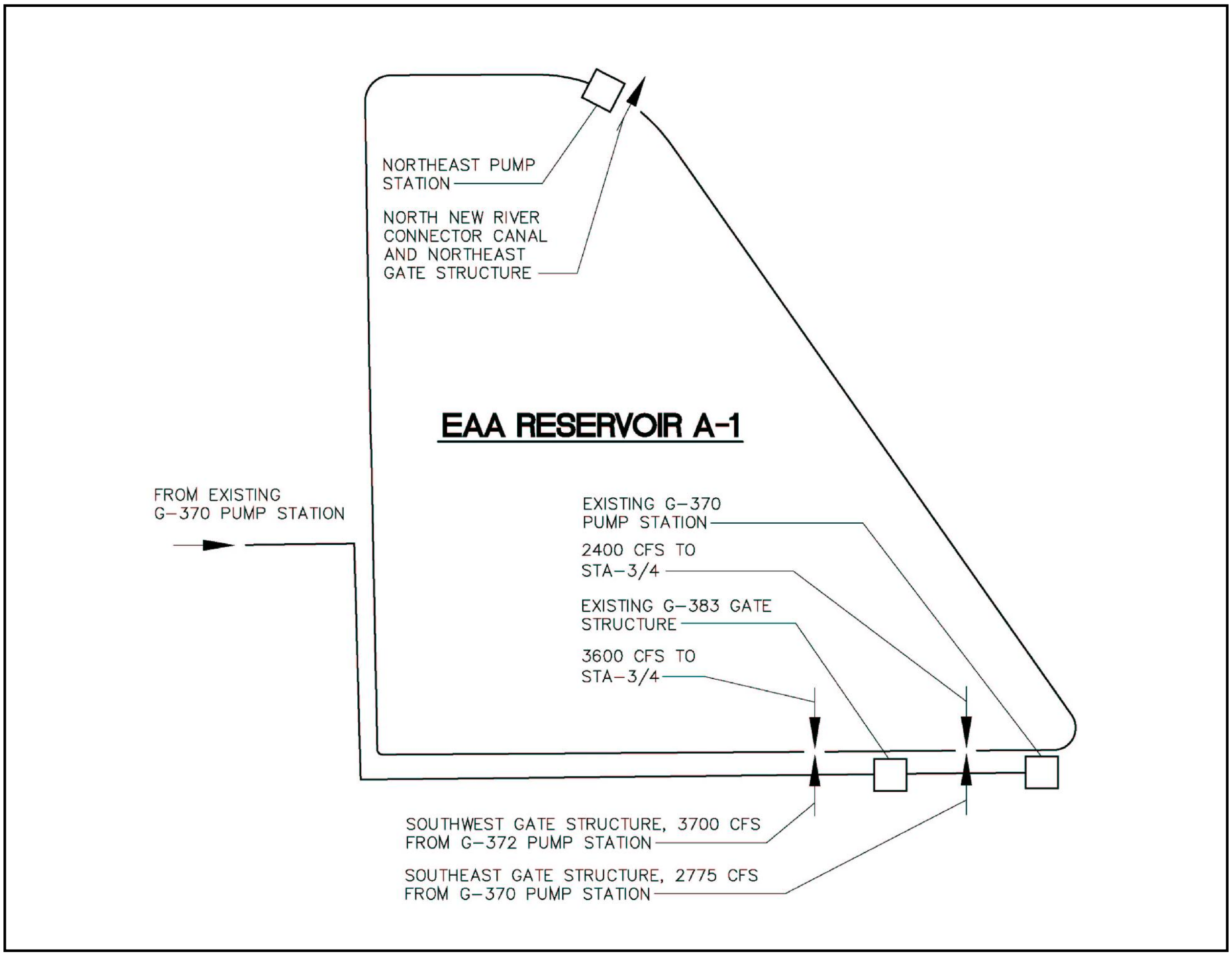


Table 7.3-4 Inflow/Supply Canal Levee Hydraulic Parameters

Canal Description	Inflow Canal[1]	Supply Canal
Canal Length	6.2 miles	10.4 miles
Canal Invert	-6.9 NAVD88	-6.9 NAVD88
Canal Bottom Width	30 to 45 feet	45 feet
Canal Side Slopes	2.5H:1V	2.5H:1V
Exterior Embankment Height	17.6 NAVD88	21.6 NAVD88
Holey Land Embankment Height	-	20.6 NAVD88
Inflow Control Embankment Height	18.1 NAVD88	-
Berm Heights	12.6 NAVD88	12.6 NAVD88
Design Maximum Flow	2,775 cfs[2]	3,670 cfs
Design Water Surface Elevation	13.6 NAVD88	15.6 (13.6) NAVD88
Design Maximum Canal Velocities	0.29 to 1.71 fps[3]	0.32 to 1.88 fps
Standard Project Storm Flow	2,775 cfs	3,670 cfs
Standard Project Storm Water Surface Elevation	16.6 NAVD88	18.6 (16.6) NAVD88
Standard Project Storm Canal Velocities	<Design Velocity	<Design Velocity

[1]The original designer distinguished between two canal sections. The portion adjacent to STA-3/4 was designated Inflow Canal while the portion abutting the Holey Land on the north and west sides of the Holey Land were designated Supply Canal. At the present time, both canal reaches are commonly referred to as the Supply Canal.
*Inflow Canal Section from G-380F to G-383 Gate Structures
[2] cfs = cubic feet per second
[3]fps = feet per second

The two gate structures will be multiple-barreled, gated concrete box culverts to allow flow into the EAA Reservoir A-1 from the inflow canal and out of the EAA Reservoir A-1 to the canals, depending on the water level and operation of the STA-3/4. Data for these structures will be developed during the design phase (see Figure 7.3-2 for a schematic of STA-3/4 structures).

7.3.4.2 Northeast Gate Structure

A new gate structure will be constructed near the northeast pump station. Its primary use will be for releasing water to the NNRC for agricultural deliveries. The gates will be available for opening in an emergency. The structure will connect to the new connector canal between the northeast pump station and the NNRC.

7.3.5 Spillway

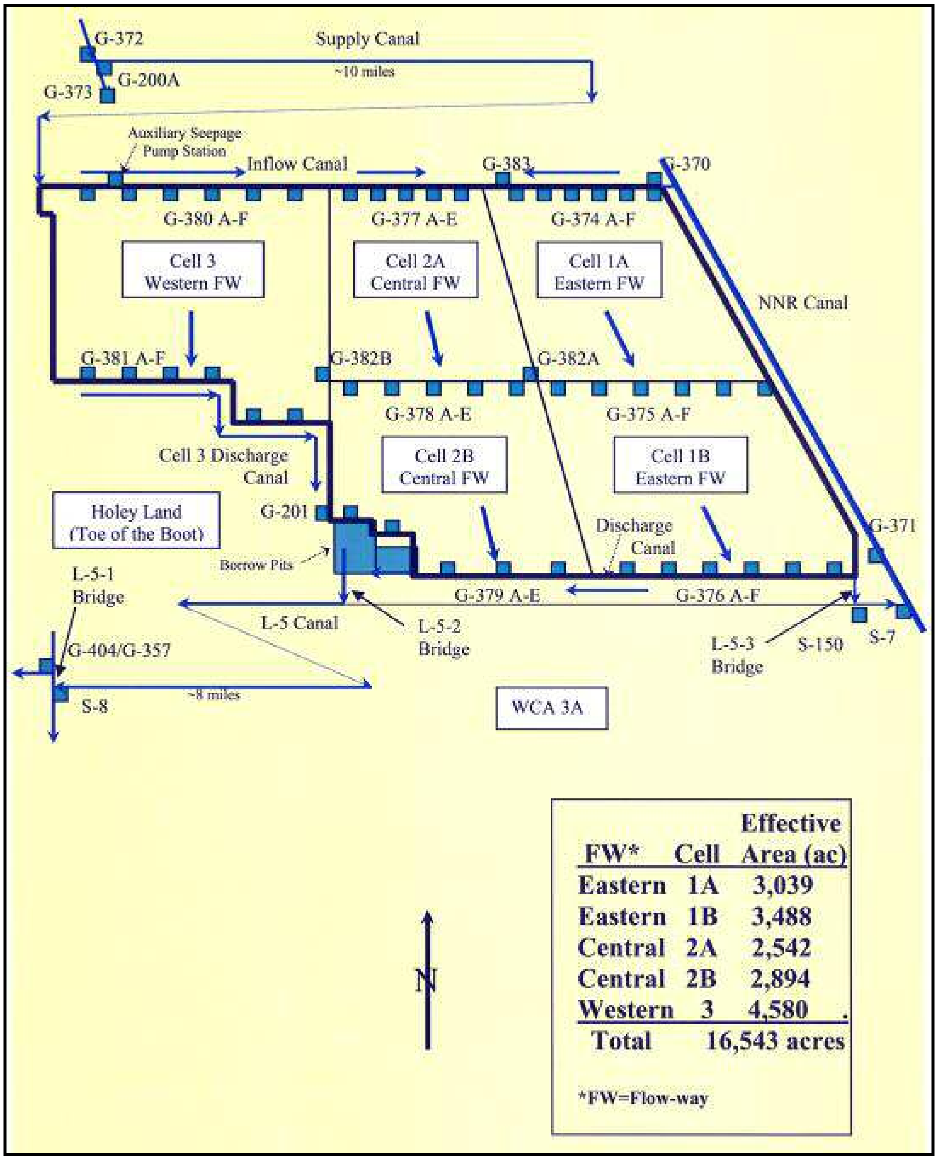
An uncontrolled orifice type spillway will be integral with the northeast gate structure near the northeast pump station. The crest will be set at an elevation of 21 NAVD88 and the orifice will be sized to limit discharges to 20 cfs per square mile (CSM) with a depth of flow over the crest of two feet. The spillway will discharge to the headwater canal for the northeast pump station and discharges will flow to the NNRC.

7.3.6 STA-3/4 Gate Structures

STA 3/4 will receive water directly from the NNRC and Miami Canal via G-370 and G-372 pump stations, respectively. A schematic of STA-3/4 structures is provided for informational purposes on Figure 7.3-2. Tables 7.3-5 and 7.3-6 provide details of the STA-3/4 gate structures.

The Project Operating Manual for STA-3/4 is not included in this POM.

Figure 7.3-2 Schematic of STA-3/4 Structures



(Not to scale)

Table 7.3-5 Supply Control Structures G-374, G-377, and G-380

Control Structure Description	G-374 A-F[1]	G-377 A-E	G-380 A-F
Number of Culverts	6	5	6
Culvert / Gate Size (H x W)	8 feet x 10 feet	9 feet x 10 feet	7 feet x 7 feet
Culvert Length (including wingwalls)	115 feet	115 feet	111 feet
Culvert Invert	0.6 feet NAVD88	-0.4 NAVD88	1.6 NAVD88
Design Inflow (each culvert)	362 cfs	396 cfs	282 cfs
Design Maximum Headwater Elevation	13.5 NAVD88	13.5 NAVD88	13.7 NAVD88
Design Low Water (Headwater) Elevation	9.6 NAVD88	9.6 NAVD88	9.6 NAVD88
Standard Project Storm (Headwater) Elevation	16.6 NAVD88	16.6 NAVD88	16.6 NAVD88
Design Maximum Tailwater Elevation	13.0 NAVD88	13.0 NAVD88	12.6 NAVD88
Design Low Water (Tailwater) Elevation	9.2 NAVD88	9.5 NAVD88	9.6 NAVD88
Standard Project Storm (Tailwater) Elevation	16.0 NAVD88	16.0 NAVD88	15.6 NAVD88
Headwater/Tailwater Data Via Telemetry	G-374 B & E	G-377 B & D	G-380 B & E
[1]Control Structure Descriptions are illustrated in Figure 7.3-1 cfs = cubic feet per second			

Table 7.3-6 Control Structure G-383

Control Structure Description	G-383
Number of Culverts	2
Culvert / Gate Size (H x W)	10 feet x 10 feet
Culvert Length (Including Wingwalls)	114 feet
Culvert Invert	-1.4 NAVD88
Design Inflow (Each Culvert)	735 cfs[1]
Design Maximum Water Elevation	13.6 NAVD88
Design Low Water Elevation	9.6 NAVD88
Standard Project Storm Elevation	16.6 NAVD88
Maximum Differential Head	1.4 feet
Headwater/Tailwater Data Via Telemetry	G-374 E and G-377 B
[1]cfs = cubic feet per second	

7.3.7 Removed Features

7.3.7.1 Auxiliary Seepage Pump Station

Existing facilities for an auxiliary pump station located in the western section of the Supply Canal near control structure G-380E include two-42 inch diameter steel discharge pipes and an equipment pad for installation of SFWMD furnished portable hydraulic pumps. It was expected that this pump station could be activated if seepage rates from the Supply Canal exceeded the capability of the G-370 and G-372 pump stations to maintain desired seepage canal levels. The existing seepage canal in this area will be eliminated with the construction of EAA Reservoir A-1, and therefore, these facilities will no longer be needed.

7.3.8 Operational Interaction of Project Features

EAA Reservoir A-1 will primarily store regulatory releases from LOK. When the EAA Reservoir A-1 is full, storm runoff will be delivered to the STA-3/4 as it was prior to construction of the EAA Reservoir A-1. During periods when the LOK water level is low and there is storage available in EAA Reservoir A-1, and depending upon hydrologic conditions and seasonal outlook, storm water runoff may also be captured in EAA Reservoir A-1. The storage of excess stormwater that can be sent to STA-3/4 at a later time will improve the quantity, timing, and distribution of water dedicated and managed for the natural system. In addition, storage of storm runoff will reduce flooding and provide water, which would otherwise have passed to tide, that can be released for agricultural purposes.

Factors which will impact operating decisions include:

- Water level in the EAA Reservoir A-1
- Lake Okeechobee water level
- Availability of water in the NNRC and Miami Canal
- Desired operating level in STA-3/4
- Impending or existing hydrologic conditions
- Environmental deliveries needed
- Agricultural deliveries needed
- Water availability from other watersheds

For normal operating conditions, the northeast pump station will be utilized to pump LOK regulatory releases into the reservoir and G-370 and G372 pump stations will be utilized to pump storm runoff into the STA-3/4. When the EAA Reservoir A-1 is full, LOK regulatory releases will be pumped into STA-3/4 from G-370 and G372 pump stations when there is little or no storm runoff. When environmental deliveries are required when there is little or no runoff and water is available in EAA Reservoir A-1, water will be released from EAA Reservoir A-1 through the southeast and southwest gate structures into the Supply Canal for distribution to STA-3/4.

EAA Reservoir A-1 will provide water for agricultural deliveries by storing LOK regulatory releases and by capturing runoff that would otherwise have gone to tide. Agricultural deliveries that cannot be met by the EAA Reservoir A-1 will continue to be supplied from Lake Okeechobee. When water is available in the EAA Reservoir A-1 for agriculture deliveries, it will normally be released through the northeast gate structure located near the northeast pump station from where it will flow to the NNRC via the connector canal for the pump station. When the EAA Reservoir A-1 water level is below that needed for gravity flow to the NNRC, pumps located in the northeast pump station will be activated.

7.4 OPERATIONAL STRATEGY TO MEET PROJECT OBJECTIVES

The Draft POM for the EAA Reservoir A-1 will be modified and revised, as necessary, through several Project phases. During the detailed design phase, the POM will be modified to define any temporary operations to be used during construction including startup and filling. The POM for STA-3/4 will also be modified as required to reflect operations during periods when construction along and within the embankments for the Supply Canals could disrupt operations.

Knowledge gained from the Operational Testing and Monitoring Phase will then be incorporated into the POM, which will be coordinated with SFWMD and the USACE South Atlantic Division (SAD), and will supersede all other iterations of the Draft Operating Plan. The final version of the Draft Operating Plan will be used by SFWMD when they accept responsibility for long-term operations of the EAA Reservoir A-1.

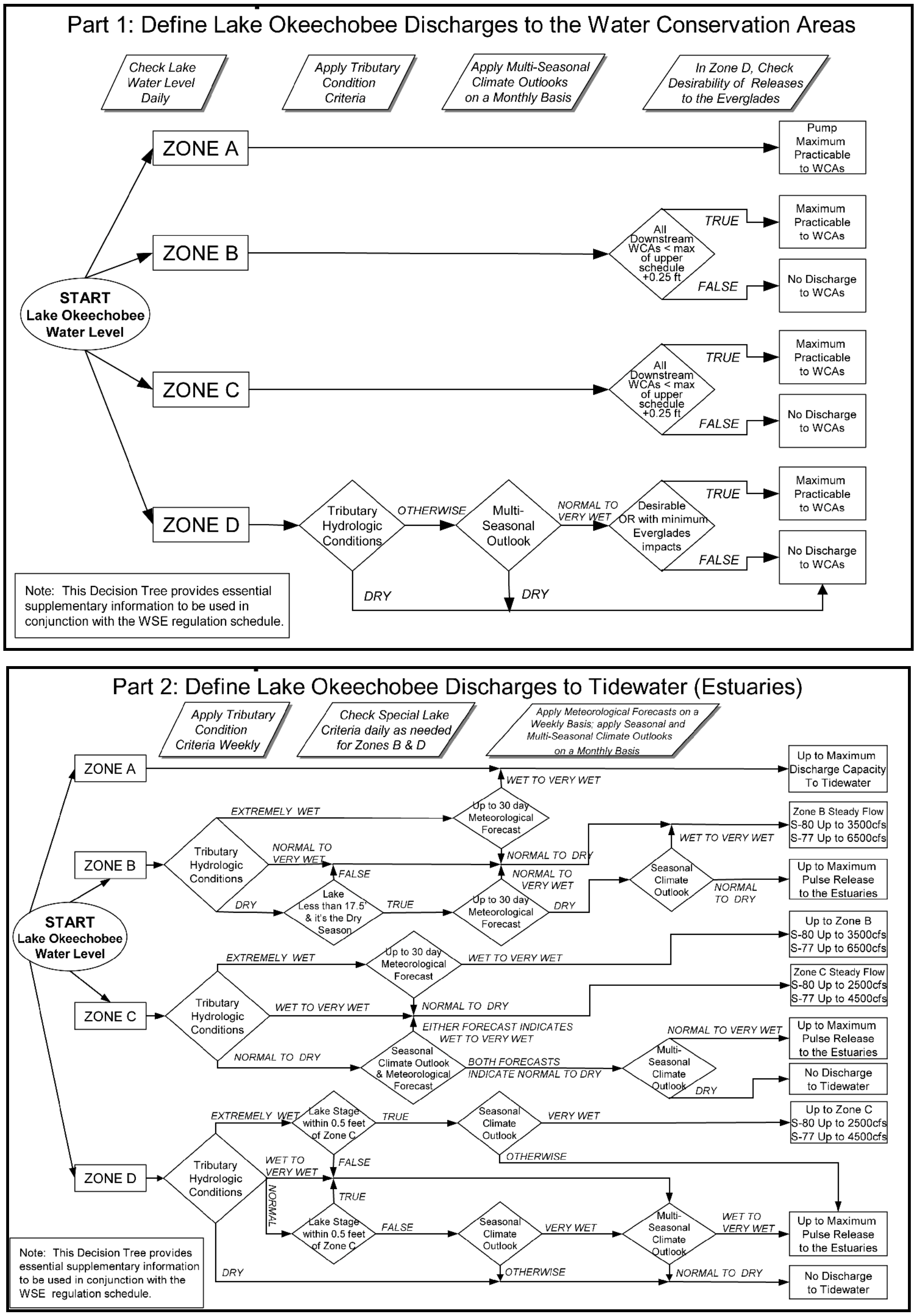
The current Lake Okeechobee regulation schedule indicates that when the Lake elevation is in zones A, B, or C, releases are made per the USACE's WSE Decision Trees (Figure 7.4-1). The construction of EAA Reservoir A-1 will allow LOK regulation discharges to be released to EAA Reservoir A-1 when storage is available, rather than to the estuaries of the Caloosahatchee and St. Lucie Rivers. During wet conditions, runoff captured by the NNRC and Miami Canal will be stored in the EAA Reservoir A-1 when capacity is available. This stored water will be used to supplement agricultural water use in the NNRC basin, and to deliver water to the environment. The need to back pump water to Lake Okeechobee will also be reduced and overall flood protection will be enhanced.

7.5 PROJECT RELATIONSHIPS AND INTERACTIONS

Operation of the EAA Reservoir A-1 and associated structures is linked to the operation of STA-3/4. Before the new facilities are in place, some modifications to the Operating Plan for STA-3/4 will be required to incorporate the EAA Reservoir A-1's storage capability for dry weather releases and for potential decreased stormwater flows to STA-3/4 during EAA Reservoir A-1 filling operations.

Other systems downstream from the STA-3/4, including the WCA-3A Everglades Protection Area may also impact operation of the EAA Reservoir A-1 system.

Figure 7.4-1 WSE Operational Guidelines Decision Trees



source: http://www.saj.usace.army.mil/h2o/lib/documents/WSE/wsedectree.pdf

7.6 MAJOR CONSTRAINTS

Constraints to the operation of the EAA Reservoir A-1 system include the availability of water in the NNRC and Miami Canal, water availability from Lake Okeechobee, the requirement of maintaining a minimum water elevation in the Supply Canal to maintain minimum stages in STA-3/4 cells, and the varying agricultural deliveries.

During drought conditions, sufficient water may not be available to completely fill the EAA Reservoir A-1 on an annual basis, resulting in potential decreased capacity to maintain environmental deliveries and agricultural deliveries during the dry season.

Since pumping to the EAA Reservoir A-1 will occur mostly during the wet season, (Lake Okeechobee regulatory releases may also be sent to the EAA Reservoir A-1 during the wet season), operation of STA-3/4 during those periods will dictate how much of the total canal flow will be available for storage. Likewise, environmental and agricultural deliveries may conflict, and therefore, constrain the distribution of the stored water for those purposes.

Minimum operating levels for both the Supply Canal and NNRC will prevent gravity releases from the EAA Reservoir A-1 when the EAA Reservoir A-1 operating level is low.

7.7 STANDING INSTRUCTIONS TO PROJECT OPERATORS

Once the operational testing and monitoring phase of components of EAA Reservoir A-1 has been completed, SFWMD will be responsible for the day-to-day water management operations. During normal conditions, the EAA Reservoir A-1 water control structures shall be operated in accordance with the approved Operating Manual for the EAA Reservoir A-1. Standing instructions will be drafted during the detailed design phase and finalized during the construction phase.

7.8 OPERATIONS TO MEET PROJECT PURPOSES

7.8.1 Achieving Natural System Goals, Objectives, and Benefits

Currently, when the Lake Okeechobee elevation is in zone A, B, C, or D (as illustrated in Figure 7.4-1), regulatory releases are made through the St. Lucie Canal and the Caloosahatchee River which flow to estuaries downstream. These releases from Lake Okeechobee have resulted in declines in aquatic vegetation and oyster populations. Upon completion of EAA Reservoir A-1, a portion of the flow that would otherwise have gone to the St. Lucie Canal and the Caloosahatchee River will be sent to EAA Reservoir A-1. When water levels in the primary canals reach predetermined levels, the G-370, G-372, and the new northeast pump stations will be operated to pump the released waters to the EAA Reservoir A-1. Stored water can later be released to the Supply Canal for environmental deliveries when the EAA Reservoir A-1 water level exceeds the minimum Supply Canal water level. When the EAA Reservoir A-1 water level is below the minimum water level for the Supply Canal, water may be released through the northeast gate structure into the NNRC from where it can be lifted into the Supply Canal by G-370 pump station. When appropriate, G-370 and G-372 pump stations can also pump Lake Okeechobee releases directly to the Supply Canals for environmental deliveries.

7.9 *FLOOD DAMAGE REDUCTION*

7.9.1 Normal and Emergency Operations

For normal operating conditions, the northeast pump station will be utilized to pump LOK regulatory releases into the reservoir and G-370 and G372 pump stations will be utilized to pump storm runoff into the STA-3/4. When the EAA Reservoir A-1 is full, LOK regulatory releases will be pumped into STA-3/4 from G-370 and G372 pump stations when there is little or no storm runoff. When environmental deliveries are required when there is little or no runoff and water is available in EAA Reservoir A-1, water will be released from EAA Reservoir A-1 through the southeast and southwest gate structures into the Supply Canal for distribution to STA-3/4.

7.9.2 Hurricane or Tropical Storm Operations

The hurricane season occurs each year from June 1 through November 30. When there are tropical depressions, tropical storms, and/or hurricanes in the Atlantic/Caribbean Basin or the Gulf Coast of Florida, the National Hurricane Center issues public advisories, forecast advisories, forecast discussions, and strike probability forecasts.

Water management operations within the EAA Reservoir A-1 during hurricanes or tropical storms should follow SFWMD Emergency Preparedness Manual Suggested Hurricane Operation Procedures, April 2004. The USACE, Jacksonville District, Emergency Operations Standard Operating Procedures document (CESAJ SOP 500-1-1) should be consulted for emergency preparation and actions.

7.9.3 EAA Reservoir A-1 Emergency Overflow/Uncontrolled Discharge

An uncontrolled orifice type spillway will be constructed as described in this Operating Manual under Proposed Features, including any required provisions for operating the EAA Reservoir A-1 to avoid re-suspension of phosphorus.

7.10 *WATER QUALITY*

Additional operational procedures to improve water quality will be developed during the detailed design phase of the EAA Reservoir A-1 Project and will be included in the final Operating Manual. This includes any required operating provisions to avoid resuspension of phosphorus.

7.11 *WATER SUPPLY OPERATIONS*

During dry conditions when water is needed for agricultural deliveries, and the EAA Reservoir A-1 level is above 11.5 NAVD88, the northeast gate structure can be opened as necessary to allow gravity discharge to supply agricultural deliveries to the NNRC. When the EAA Reservoir A-1 water level is below that elevation, provisions will be available at the northeast pump station to pump water from EAA Reservoir A-1 back to the NNRC.

If environmental deliveries are needed and the water level in the EAA Reservoir A-1 is above the water level in the Supply Canal, water can be released through the southeast and southwest gates. If the EAA Reservoir A-1 water level is less than the required water level in the Supply Canal, water can be released through the northeast gate structure near the northeast pump station, or pumped from the northeast pump station to the NNRC and then pumped by G-370 gate structure from the NNRC into the Supply Canal. G-383 pump station would be opened to allow flow to the western flow ways.

7.12 RECREATION

Activities such as fishing and boating will be permitted at the discretion of the SFWMD. No special operations will be required.

7.13 FISH AND WILDLIFE

Existing canals within the EAA Reservoir A-1 site, along with borrow canals and quarry areas, will provide deep-water refugia. In addition, littoral shelves will be incorporated along the seepage canal. No special operations will be required.

7.14 PRESTORM/STORM OPERATION

If there is unused storage capacity in the EAA Reservoir A-1, the preferred operating mode will be to maximize pumping into the EAA Reservoir A-1 during storm events. This operation would decrease the impact of high flow stormwater events on STA-3/4. If the northeast pump station is operating to full capacity and the NNRC has excess flow, G-370 pump station will be activated to pump into the EAA Reservoir A-1 or directly into STA-3/4.

If a heavy rainfall is forecasted by the National Weather Service Advisories and SFWMD, a pre-storm drawdown of EAA Reservoir A-1 may be initiated to increase available storage capacity. Storage may be created by discharging to the NNRC through the northeast gate structure or to the Supply Canal through the southeast and southwest gate structures. The ability to discharge to either the environment or to the NNRC will be a function of the water depths and flows at the time.

If the EAA Reservoir A-1 exceeds the normal maximum operating pool as the result of a storm, operations would include drawdown of the EAA Reservoir A-1 by releasing water to STA-3/4 and/or NNRC in order to bring the water level back to the normal maximum operating pool.

7.15 CONSISTENCY WITH THE IDENTIFICATION OF WATER RESERVATIONS OR ALLOCATIONS FOR THE NATURAL SYSTEM

Certain EAA Reservoir A-1 Project assurances analyses are not yet complete. This section will be updated during the detailed design phase. The appropriate quantity, timing and distribution of water for the natural system and other water related needs will be identified in the PIR.

The EAA Reservoir A-1 will store some runoff that would otherwise have gone to tide and will improve the timing and distribution of water deliveries to the environment. It has been demonstrated using an area specific computer model, and POS data from the SFWMM (which is the same as the EPC 2010 and 2015 version 5.4.2), that more than 600,000 acre-feet per year can be delivered to the environment by EAA Reservoir A-1. Operating criteria for EAA Reservoir A-1 will be developed in subsequent versions of this manual to be consistent with the water reservations or allocations for the natural system made by the State in accordance with Section 373.1501(5) F.S.

7.16 CONSISTENCY WITH SAVING CLAUSE AND STATE ASSURANCES PROVISIONS

During periods when EAA Reservoir A-1 contains water and it is necessary to prevent seepage from impacting adjacent properties, the seepage canal water level can be pumped down as required to prevent the groundwater level from rising. A groundwater model has been utilized to verify that depressing the seepage canal will be effective in preventing flooding of adjacent properties.

The EAA Reservoir A-1 will provide capacity for storage of LOK regulatory releases and some storm runoff and will increase the pumping capacity from the NNRC. In addition, the area occupied by the EAA Reservoir A-1 previously used for agriculture will no longer deliver runoff to the NNRC, thereby making available 500 cfs of NNRC capacity that was previously unavailable. Therefore, the Project will not diminish flood protection and should reduce flooding in the NNRC.

The Project will store some runoff that would otherwise have gone to tide and will, therefore, provide water for agricultural uses during the dry season. It has been demonstrated using an area specific computer model that a high percentage of the agricultural deliveries along the NNRC can be provided by EAA Reservoir A-1.

A berm will be constructed outside of the seepage canal and any runoff between the berm and the EAA Reservoir A-1 embankment will be collected in the seepage canal and delivered to the EAA Reservoir A-1.

7.17 DROUGHT CONTINGENCY PLAN

During a drought in the EAA Reservoir A-1 Project area, operations will be in accordance with SFWMD Rules, Chapter 40E-21, F.A.C., Water Shortage Plan.

7.18 FLOOD EMERGENCY ACTION PLAN

The Flood Emergency Action Plan will be completed for the EAA Reservoir A-1 prior to completion of construction. The Flood Emergency Action Plan to be developed should be consulted for related emergency preparation and action. Local emergency management offices will be provided copies of the Flood Emergency Action Plan as necessary. This plan may be used to supplement Hurricane or Tropical Storm Regulations. As outlined in USACE Engineering Regulation 1130-2-530, the Flood Emergency Action Plan shall include:

- A written Emergency Notification Procedure for serious abnormal conditions to provide for safety of people in the vicinity of the EAA Reservoir A-1 area and also to trigger immediate response for remedial assistance to the embankment and water control structures
- A description or list of conditions leading to emergency situations and ways of dealing with them should they occur
- Storage area dewatering procedures
- Embankment and water control structure failure inundation maps
- Listing of location, types, and quantity of emergency repair materials and equipment
- Details outlining responsibilities for inspection and execution of emergency repairs

- List of contractors available within a reasonable distance of the EAA Reservoir A-1

7.19 DEVIATIONS FROM NORMAL OPERATING CRITERIA

The USACE District Commander is occasionally requested by the non-Federal sponsor to approve deviations from normal operation criteria. Prior approval for a deviation is required from USACE-SAD except as noted in paragraphs below. Deviation requests usually fall into the following categories:

7.19.1 Emergencies

Emergencies that can be expected include water recreation related accidents such as drowning or boating accidents, failure of EAA Reservoir A-1 facilities, and flushing of pollutants. Water control actions necessary to abate the problems should be implemented immediately unless such action would create worse conditions. The USACE-SAD office must be informed of the problem and the emergency operating changes as soon as practical. In addition, the non-Federal sponsor, the State of Florida (Florida Department of Environmental Protection and SFWMD), and the U.S. Department of the Interior should be informed.

7.19.2 Unplanned Minor Deviations

There are unplanned instances that create a temporary need for minor deviations from the normal operating criteria, although they are not considered emergencies. Construction accounts for the major portion of incidents requiring minor deviations. Deviations are also sometimes necessary to carry out the maintenance and inspection of facilities. Request for changes in release rates generally involve time periods ranging from a few days to a few weeks. Each request should be analyzed on its own merits. In evaluating the proposed deviation, consideration must be given to low flow requirements, fish and wildlife, water rights, roles of the USACE and the SFWMD, short-term release scheduling, long-range release planning, and storage utilization (seasonal commingled, joint use).

7.20 SEEPAGE CONTROL

The EAA Reservoir A-1 will be constructed immediately north of the existing Supply Canal. The embankment for the EAA Reservoir A-1 will be constructed over the existing seepage canal along the north side of the Supply Canal. Therefore, the existing seepage pumps in G-370 pump station will not serve their original purpose but may be connected to the seepage canal along the east side of EAA Reservoir A-1.

New seepage canals will be constructed along the northern, western, and eastern sides of the EAA Reservoir A-1 and will convey seepage to the new northeast pump station. Seepage pumps in that facility will be designed to pump the seepage flow back into the EAA Reservoir A-1.

7.21 INITIAL RESERVOIR/TREATMENT AREA FILLING PLAN

The Initial Storage Filling Plan (ISFP) is defined as a deliberate impoundment of water to meet Project purposes and is a continuing process as successively higher water levels are attained. The initial EAA Reservoir A-1 filling is the first opportunity to test whether the containing embankments and water control structures will perform as designed. To monitor this performance, the rate of filling will be controlled to the extent feasible to allow as much time as needed for implementation of a predetermined monitoring program, including the observation and analysis of instrumentation data. Information furnished in the ISFP will generally be concerned with action that can be taken without a significant impact to Project purposes, provided no unsafe conditions are observed. An ISFP will be developed during design and construction. The ISFP will include but is not limited to the following:

- Preferred filling rate and the available options to control the rate of filling, as well as the consequences of operation with the prime objective of controlling the rate of EAA Reservoir A-1 water level rise
- The most likely type of problem(s) that may develop during initial filling and the monitoring necessary to detect those problems
- A description of the proposed hydrologic data collection and transmission system, and a plan for reading the instruments and evaluating the data with regard to the filling plan
- A plan for inspecting the embankment and downstream areas prior to and during filling, including the relationship between frequency of inspection and rate of pool rise
- Instructions for observers on conditions that require immediate attention of personnel authorized to make emergency decisions. Clearly identify who is responsible for decisions and how they can be contacted. Alternative decision makers should be identified
- An emergency plan listing responsibilities, name and/or positions, telephone numbers, pager numbers, and radio frequencies to be used
- Water quality requirements, if any, for the initial filling

7.22 WATER CONTROL DATA ACQUISITION SYSTEM PLAN

The remote automation components installed at the pump stations and other structures are RTU and communications channel to SFWMD control center. The access for the RTU to the control center is via field interface units (FIU). The automation components of all pump stations and structures that will eventually be operated and maintained by SFWMD will conform to SFWMD standards.

7.23 CONSISTENCY WITH THE ADAPTIVE MANAGEMENT PROGRAM AND PERIODIC CERP UPDATES

After initiation of long-term operations and maintenance of the EAA Reservoir A-1, the Operating Manual may be further modified based on operating criteria approved by the USACE and the SFWMD that results from CERP updates and/or recommendations from the adaptive assessment process as outlined in Guidance Memorandum Number 6 of the Programmatic Regulations.

8.0 LIST OF DRAWINGS

The following drawings are included as Volume 2 of this Preliminary Design Report.

GENERAL DRAWINGS

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1	G01	CN040932–WO13–G01	Cover Sheet and Location Map
2	G02	CN040932–WO13–G02	Sheet List
3	G03	CN040932–WO13–G03	Legend and Abbreviations
4	G04	CN040932–WO13–G04	General Notes and Quantity Table
5	G05	CN040932–WO13–G05	Horizontal and Vertical Control
6	G06	CN040932–WO13–G06	Site Exploration Data
7	G07	CN040932–WO13–G07	Land Use Plan During Construction

CIVIL DRAWINGS

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9	C02	CN040932–WO13–C02	Typical Section and Baseline Data
10	C03	CN040932–WO13–C03	Embankment and Canals Plan – Sheet 10
11	C04	CN040932–WO13–C04	Embankment and Canals Plan – Sheet 11
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24	C17	CN040932–WO13–C17	Typical Embankment Cross Sections
25	C18	CN040932–WO13–C18	Typical Embankment Cross Sections
26	C19	CN040932–WO13–C19	Typical Canal Cross Sections
27	C20	CN040932–WO13–C20	Existing Canal Crossings
28	C21	CN040932–WO13–C21	Exterior Access Ramps – Type 1

Sheet Number	Drawing No.	Filename	Sheet Title
29	C22	CN040932–WO13–C22	Exterior Access Ramps – Type 2 and 3
30	C23	CN040932–WO13–C23	Turnouts and Turnarounds – Plans
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32	C25	CN040932–WO13–C25	Demolition Site Plan
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35	C28	CN040932–WO13–C28	Demolition – U.S. 27 Entrance Road
36	C29	CN040932–WO13–C29	Demolition – North Agricultural PS
37	C30	CN040932–WO13–C30	Demolition – U.S. 27 Entrance Road
38	C31	CN040932–WO13–C31	Demolition – U.S. 27 Entrance Road
39	C32	CN040932–WO13–C32	Demolition – South Agricultural PS
40	C33	CN040932–WO13–C33	Demolition – Seepage Pump Pad and Piping
41	C34	CN040932–WO13–C34	Earthwork Balance and Quantity Estimates
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9.0 LIST OF TECHNICAL SPECIFICATIONS FOR THE EAA RESERVOIR A-1 EMBANKMENTS

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(Not used)

DIVISION 8: DOORS AND WINDOWS
(Not used)

DIVISION 9: FINISHES
(Not used)

DIVISION 10: SPECIALTIES
(Not used)

DIVISION 11: EQUIPMENT
(Not used)

DIVISION 12: FURNISHINGS
(Not used)

DIVISION 13: BUILDING
(Not used)

DIVISION 14: CONVEYING SYSTEMS
(Not used)

DIVISION 15: MECHANICAL
(Not used)

DIVISION 16: ELECTRICAL
(Not used)

END OF DIRECTORY

10.0 OPINION OF PROBABLE COST

The Opinion of Probable Cost is a completely separate document that is not included as part of this Preliminary Design Report.

11.0 EMBANKMENT CONSTRUCTION SCHEDULE

An overview schedule has been developed showing major work items and possible constraints to the overall embankment construction project. Detailed scheduling of the embankment construction by production rates or select segments of the required work is dependent on the approach considered most appropriate by the Construction Manager-at-Risk (CM-at-Risk).

The overall productivity and production cycling at this point are unknown and detailed sequencing of activities should include input from the selected CM-at-Risk

The generic sequence of major embankment construction activities is outlined as follows:

- Clearing & grubbing
- Run-off control measures construction
- Muck stripping
- Blasting of caprock
- Excavation & stockpiling of caprock
- Silty sands excavation & stockpiling (random fill)
- Dewatering/stabilization period of stockpiled random fill for minimum of 3 months
- Cleaning of the caprock (concurrent with dewatering period)
- Placement of caprock to PMP level
- Trenching & excavation of the seepage cut-off wall
- Slurry cut-off wall construction
- Placement of filter drains
- Placement of random fill and rock to crest level
- Placement of RCC slope protection
- Build up of the embankment to crest level with RCC
- Topsoil & seeding
- Perimeter road construction

Lag/lead items that are likely to occur will be imposed by:

- Blasting and required safety distances (safety)
- Random fill material excavation and dewatering (technical)
- Tie-ins of headings at demolition points (technical)

- Tie-ins of the slurry wall sections (technical)
- Number of concurrent heading required to finish within specified time frame (construction method)
- Access to the interior area in order to initiate demolition of access roads, pump stations, culverts and power lines to complete the embankment

Traffic control along U.S. 27 was briefly addressed and will have to be scoped out further with input from affected stakeholders.

An initial blasting monitoring and validation program will be required before construction along U.S. 27 can commence.

The excavation and completion of the Northeast Connector Canal must be coordinated with the construction of the Northeast pump station.

A Substantial Completion date for the construction of the embankment has been shown for January 2009. Final Completion for the project is shown to be in May 2009 and start-up of the pump station is expected to occur in Substantial Completion and Final Completion of the embankment.

Given the climatic conditions in the geographic area of the project, inclement weather impacts on the project completion milestones should be discussed with input from the CM-at-Risk.

12.0 CALCULATIONS

Calculations on the following topics are included in this Section.

Topic	**Computed by**	**Verified by**
• Longitudinal Soil Profiles	Alston Noronha	Dominic Molyneux
• Rockfill Design Parameters	Paul Zaman	Don Gupta
• Seepage Collection Canal Hydraulic Calculations	Frank Means	Jim Touslee
• 100 Year Flood Elevation	Gail Montgomery	Jim Touslee
• Embankment Seepage Analysis Calculations	Sanyam Dangayach	Dominic Molyneux
• Slope Stability Analyses Results	Jacques Moraille	Don Gupta
• Seismic Evaluation – Liquefaction Analysis	Sanyam Dangayach	Norm Holst
• Seismicity	Norm Holst	Paul Zaman
• Everglades Blasting Considerations	Norm Holst	Tom Knox
• Settlement	Dick Vaeth	Alston Noronha
• Filter Design	Alston Noronha	Dick Vaeth
• Access Road Design	Tom Knox	Don Gupta